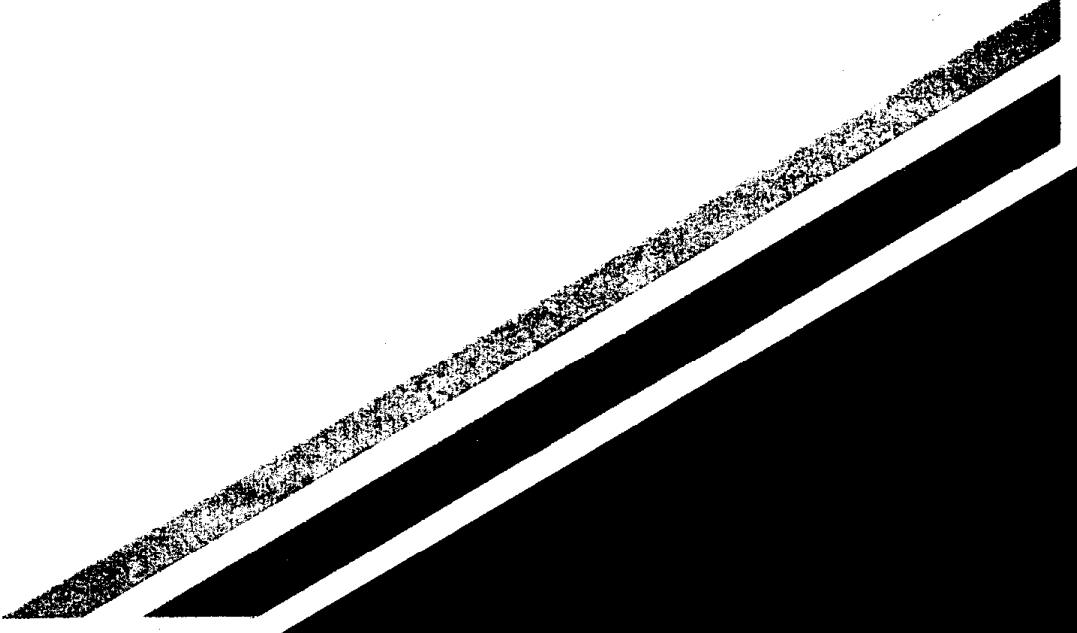




CONTRACT NO. 95-313
FINAL REPORT
SEPTEMBER 1999

Evaluation of Fuel Cell Reformer Emissions

Appendix A: Partial Oxidation Fuel Processor Gas Composition and Emission Test Data Report



CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY



AIR RESOURCES BOARD
Research Division

EVALUATION OF FUEL CELL REFORMER EMISSIONS

APPENDIX A: PARTIAL OXIDATION FUEL PROCESSOR GAS COMPOSITION AND EMISSION TEST DATA REPORT

**FINAL REPORT
CONTRACT NO. 95-313**

PREPARED FOR:

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SEPTEMBER 1999

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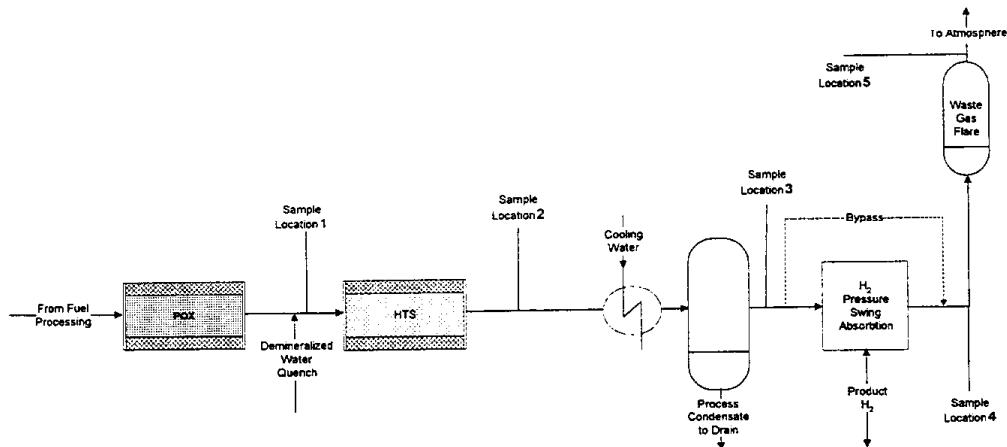
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1. INTRODUCTION

This Appendix contains the result of the testing of the Underoxidized Burner (UOB™) developed by Hydrogen Burner Technology (HBT) (Long Beach, California) to produce hydrogen from methane, water and air making use of the partial oxidation (POX) process. Vehicles powered with proton exchange membrane fuel cells (PEMFC) and POX fuel processors are a leading candidate for passenger cars. A POX system can operate on a variety of fuels which would make fuel cell powered vehicles feasible throughout a greater geographic area and not as dependent on fuel infrastructure. The primary focus of the fuel cell program for passengers cars at the United States Department of Energy is PEMFCs with multi-fuel fuel processors such as a POX system. The HBT system was tested at various loads, start up, and transient operation. The data was evaluated and incorporated into a vehicle simulation model to determine g/mi emissions.

The HBT UOB™ system is used for industrial hydrogen generation and has several key differences from a vehicle fuel processor system. The HBT unit operates at 150 psi and is much heavier than a vehicle system. The higher operating pressure could result in higher ammonia levels in the gas stream since increased pressure favors ammonia formation. The stationary hydrogen generation system requires an hour to warm up compared to a few minutes or less for a vehicle system. Emission data from any system during warm up is limited and these data contribute to the data base of available information. The stationary hydrogen system operates as a POX reactor with no steam addition. Consequently, the stoichiometric ratio is near 0.45 which is higher than that of the planned vehicle systems. While there are important differences between a stationary system and a vehicle system, the following emission data provides insight into trends in criteria pollutants from POX systems. Hydrocarbon (HC) emissions are particularly important since they relate to non-methane organic gases (NMOG), which are regulated in ARB vehicle exhaust standards. The NMOG standard is the most challenging pollutant level for a fuel-cell-powered vehicle to meet in order to comply with ARB's super low emission vehicle (SULEV) standard. Analyzers are configured to detect total hydrocarbons (THC), which include methane, while NMOG excludes methane. The THC measurement is expected to correlate with NMOG.

A flow diagram illustrating the UOB™ system is provided in Figure 1. The diagram shows the components of the UOB™ system and the sampling locations for gas composition measurements. The UOB™ system utilizes an under-oxidization process that can use various hydrocarbon feeds and oxidant mixtures. These gases are preheated as they are injected into the UOB™ unit (POX). Only a small amount of the fuel is combusted to sustain the operating temperature. At the elevated operating temperature, the remaining fuel is broken into hydrogen, carbon dioxide, and carbon monoxide. This raw gas is then quenched with water as it enters the CO high-temperature shift reactor (HTS) where catalysts are used to react the CO with water to produce more hydrogen and carbon dioxide. In traditional concepts an additional CO removal step is required to produce the purity needed for a PEMFC. The UOB™ fuel processor is controlled by varying the air and fuel flow to the reaction and the water flow to the downstream quench. Feedback control logic is used based on simple temperature measurements. The operating parameters for the UOB™ system are shown in Tables 1 and 2.



Sampling locations:

1. At the exit of the UOB™, or partial oxidation reactor, after the quench water injection
2. At the high temperature shift reactor exit
3. After the cooling/condenser unit
4. After the pressure swing adsorption (PSA) waste gas exit
5. Flare

Figure 1. HBT UOB™ process diagram

Table 1. System temperatures

No.	Sampling Location (under full load)	Temperature (K)
—	UOB™	1755
1	POX after quench HTS inlet	560
2	HTS exit	577
3	Condenser/Cooling Unit outlet	286
4	PSA waste gas	286
5	Flare exhaust	1000

Table 2. System operating parameters and flowrates

Parameter (under full load)	Capacity
Natural Gas feed	7.3 kg/h
Natural Gas feed	106 kW, HHV
Air feed	60 kg/h
Stoichiometric ratio, λ	0.45
Hydrogen production	1.39 kg/h
Hydrogen Production	55 kW, HHV
Total Efficiency	52%

2. TEST MATRIX

The reformer emission and product gas composition test matrix is summarized in Table 3. Process gas constituent concentrations were measured at steady-state, transient load changes, and startup operating conditions at the sample locations specified in Table 3. Measurement parameters include oxides of nitrogen (NO_x), carbon dioxide (CO_2), carbon monoxide (CO), total hydrocarbons (THC), oxygen (O_2), formaldehyde (HCHO), ammonia (NH_3), and moisture content. Hydrocarbon compositions were also determined.

The gas compositions vary throughout the UOB™ system as various reaction steps affect the product gas to produce pure hydrogen. The POX product gas is quenched which reduces the gas temperature in order to prevent two CO molecules from reacting to form soot and CO_2 . Water also evaporates during the quenching process and provides steam for the HTS reaction. In principal, hydrocarbons that remain from the POX reaction will pass through the system without being further affected. This point in the gas stream is sample location 1. CO reacts with steam to produce hydrogen and CO_2 in the HTS (sample location 2). The industrial HBT system is not equipped with a low temperature shift reactor, so no further reactions take place. The HTS product gas is cooled and moisture is removed in a condenser. In this step, ammonia can be removed since it is soluble in water. Formaldehyde that is produced in the POX can also be absorbed in the condenser water. After the gas stream exits the condenser, almost all of the water is removed (sample location 3). The gas composition is expected to be the same as that of sampling location 2 except water soluble components will be removed. The pressure swing adsorption (PSA) unit separates hydrogen from the product gas. The PSA waste gas (sample location 4) is burned in the flare (sample location 5).

Two different gas mixtures can be burned in the flare. The PSA waste gas can be burned in the flare and the hydrogen routed to another location, which is referred to as Condition 3 (C3). Operating under C3 resembles burning the waste anode gas from a fuel cell. The PSA waste gas is similar in composition to the waste anode gas mixture from a fuel cell. Most of the hydrogen is removed by either the PSA or the fuel cell, leaving behind a mixture of CO_2 , N_2 , and CO. Either the fuel cell or the PSA removes about 80 percent of the hydrogen from the reformer

product gas. In a PEMFC system, the CO content will be much lower since a low-temperature shift (LTS) and CO clean up system will reduce the CO to below 20 ppm. However, hydrogen, CO₂, and trace hydrocarbon levels can be similar. For Condition 2 (C2) all of the reformer product gas is burned. The gases bypass the PSA and go directly to the flare. The gas mixture for C2 is equivalent to the PSA waste gas plus product hydrogen.

Table 3. Emission test matrix

No.	Sampling Location	System Operating Condition	CEM ^a	HCHO (TO-11) ^b	Moisture/NH ₃ (ST-1B) ^c	Speciated HC ^d
1	POX after quench	Full load	Y	Y	Y	Y
2	Shift Exit	Full load	Y	Y	Y	Y
3	After CCU ^e	Full load	Y	Y	Y	Y
3	After CCU ^e	100% – 80% load	Y	Y	N	N
3	After CCU ^e	80% – 110% load	Y	N	N	Y
4	PSA waste gas	Full load	Y	Y	Y	Y
5	Flare	Full load C2 ^f PSA waste + H ₂	Y	Y	Y	Y
5	Flare	Full load C3 ^g	Y	Y	Y	Y
5	Flare	Start-up, flare pilot only C2	Y	N	N	N
5	Flare	Start-up, POX pilot only C2	Y	N	N	N
5	Flare	Start-up, begin POX C2	Y	N	N	N

^aCEM: Continuous emissions monitoring. Includes NO_x, CO, CO₂, THC, and O₂, see Attachment A for results.

^bUSEPA - Method, see Attachment B for results.

^cBAAQMD - Method, see Attachment C for results.

^dUSEPA Method TO-14 and ASTM D-1945, see Attachment D for results.

^eCCU = Condenser/Cooling Unit

^fC2 = H₂ from PSA plus PSA waste gas

^gC3 = PSA waste-gas to flare. H₂ goes to another location.

3. EMISSION MEASUREMENT PROCEDURES

Process and exhaust gas constituent concentrations were measured following the methods summarized in Table 4. Concentrations of NO_x, CO, CO₂, O₂, and THC were measured following California Air Resources Board (ARB) Method 100. Formaldehyde and speciated HCs were measured following United States Environmental Protection Agency (USEPA) Method TO-11 and TO-14, respectively. Ammonia was measured following Bay Area Air Quality Management District (BAAQMD) Source Test Method 1B (ST-1B). Exhaust gas volumetric flow rates were too low to be determined by USEPA Methods 1 through 4, instead they were calculated from the carbon balance in the POX feed and CO₂ in the exhaust stream.

To verify the CEM and in order to test for further components, HBT provided an MTI Analytical Instruments® gas chromatograph (GC). The instrument operated in parallel with the above-mentioned analyzers. The sampling rate was approximately 0.5 L/min. The operating range of the GC is shown in Table 5.

Table 4. Test methods

Species	Method^a
NO _x , CO, CO ₂ , O ₂ , THC	California ARB Method 100, CEM
HC speciated	Sample collection – EPA Method 18, SUMMA® Canister, EPA TO-14 (GCMS), ASTM D-1945 (GC/TCD/FID)
Ammonia	BAAQMD ST-1B, 0.1N HCl impingers
Formaldehyde	EPA TO-11, DNPH cartridges
Moisture content	EPA Method 4

^aReferences for test methods are listed in Section 5.

Table 5. Operating sensitivity of MTI GC

Component	Approximate Range (%)
Ethane	0 - 1
Propane	0 - 1
Ethylene	0 - 1
Acetylene	0 - 1
Methane	0 - 1
CO ₂	0 - 5
CO	0 - 15
H ₂	0 - 20

3.1 Continuous Emission Monitoring

Exhaust and process gas concentrations of NO_x, CO, CO₂, O₂, and THC were measured using the instrumentation identified in Table 6 according to California ARB Method 100. The sampling and analysis laboratory was operated according to the following techniques. A sample pump extracts the sample gas continuously from the source through a stainless steel sampling probe equipped with an in-stack filter and cooling unit (where necessary) followed by a Baldwin sample conditioner. Gas flow is controlled with a back-pressure regulator. Sample flow to each instrument is controlled with individual rotometers. Instrument output is recorded using a strip chart recorder and a digital data logger.

Table 6. ARCADIS Geraghty & Miller mobile sampling laboratory instrument specifications

NO_x / NO CHEMILUMINESCENT ANALYZER—THERMO ELECTRON MODEL 10A	
Response Time (0-95%)	5 sec—NO _x mode
Zero Drift	Negligible after 1/2 hour warm-up
Linearity	±1% of full scale
Accuracy	±1% of full scale
Output	0-10 V
Range	0-2.5, 10, 25, 100, 250, 1000, 2500, and 10,000 ppm
Sensitivity	0.1 ppm
O₂ ANALYZER, FUEL TYPE—TELEDYNE MODEL 326A	
Response Time (0-95%)	40 sec
Accuracy	±1% of scale at constant temperature; ±1% of scale at ±5% of reading, whichever is greater, over the operating temperature range
Output	0-100 mV
Range	0-5, 10, 25 %
THC FLAME IONIZATION DETECTOR—JUM HEATED CHAMBER	
Response Time (0-95%)	30 sec
Zero Drift	±1%
Span Drift	±1%
Linearity	±1%
Output	0-10V
Range	0-10, 100, 1000, 10000 ppm
CO₂ INFRARED ANALYZER—ANARAD AR 500	
Response Time (0-95%)	30 sec
Zero Drift	±1%
Span Drift	±1%
Linearity	±1%
Output	0-100 mV
Range	0-20 %
CO INFRARED ANALYZER—HORIBA MODEL CFA-321	
Response Time (0-95%)	30 sec
Zero Drift	±1%
Span Drift	±1%
Linearity	±1%
Output	0-1 V
Range	0-200, 1000 ppm
CO INFRARED ANALYZER—FUJI MODEL 3300	
Response Time (0-95%)	30 sec
Zero Drift	±1%
Span Drift	±1%
Linearity	±1%
Output	4-20 mA, 0-1 V
Range	0-2, 0-5 %

Prior to testing, the sampling and monitoring system were assembled at HBT and leak checked. Calibrations were performed for each of the instruments using certified calibration gases. An analyzer calibration error check was performed on each instrument to assess instrument linearity. For this check, calibration gases were introduced to each instrument, and the responses were recorded on a field data sheet. If the difference between the known concentration of each calibration gas and the analyzer response was 2 percent for each of the calibration gases, then the analyzer calibration error check has been considered valid. A bias calibration check was performed prior to each sample run, and a bias span drift check was performed at the end of each run to measure analyzer drift. The bias drift check measurement uses a zero gas (nitrogen) and either a mid-range or high-range calibration gas, whichever most closely approximates the stack gas concentration. Calibration gases for the CEM testing are shown in Table 7. In general, all California ARB Method 100 sampling periods were at least 15 minutes.

Table 7. Calibration for the CEM testing

Component	Calibration Gases
CO	13, 177, 72, 826 ppm
CO ₂	6, 15 %
NO _x	20, 213 ppm
THC	28, 50, 500, 860, 9000 ppm
O ₂	5, 20 %

HBT supplied an MTI Analytical Instruments gas chromatograph, instrument ID: 161012, to measure CO in the range of 3 to 15%. The sampling-time for each run was about 160 sec. During CEM runs for the HTS exit gas, 4 GC samples were taken to confirm CO₂ readings, determine hydrogen content, and provide a high range CO measurement.

Attachment A includes the results of CEM testing. The results show NO_x, THC, CO₂ and CO during the course of testing. CO from the CEM is identified as CO-lo since it was measured with a low range analyzer. High range CO was determined with the on-line GC. The first series of tests characterized the emissions from the flare burning PSA product gas, PSA product gas and hydrogen and during start-up (A-3 through A-7). The results indicated that THC levels from the flare during reforming were so low that further testing of the flare was not necessary. THC and CO emissions during portions of the start-up (A-6, A-7) were higher than those during the combustion of PSA product gas (A-3, A-4). The start up emission data includes a pilot burner for the flare (A-5) where natural gas is burned without any feed from the UOB™. The flare is a typical industrial design with a pilot burner and process gas burner. Air enters the flare through natural convection (without a fan). CO rises as the flare warms up, which may be due to the air flow characteristics of the flare. The POX pilot burner then starts by burning a near stoichiometric mixture of air and natural gas (A-6). A rise in THC and CO can be observed at the end of A-5 when the POX burner starts operation. Fluctuations in CO₂ and CO in the pilot burner emissions (A-6) reflect a cycling in fuel flow rate. The UOB™ was warmed up over a two-hour period. The heavy construction of the industrial unit requires a much longer warm up

period than would be required for a vehicle system. The transition from start up operation to reforming can be observed at the beginning of A-7. During start up, CO emissions from the POX pilot burner are over 1000 ppm as the burner operates near stoichiometry and no additional combustion takes place in the flare. CO emissions are out of range of the analyzer for the first 5 minutes at the start of reforming (A-7). Once reforming begins, the POX unit operates at a richer stoichiometry and the product gases enter the flare and are combusted. The second combustion step reduces THC and CO emissions. CO concentrations drop when the UOB™ makes a transition from warm up to burning PSA waste gas and hydrogen (A-7). Subsequent testing focused on characterizing the THC content in the POX product gas and downstream reactors.

The THC levels in the UOB™ product gas can be observed at various sampling locations and during a load change (A-8 through A-13). The effect of a load change was monitored while measuring the HTS product gas after the condenser. Reducing the load from 100 percent to 80 percent temporarily results in a drop in THC concentration (A-11). This effect can be due to a slight increase in stoichiometry as load is reduced. Also, the gas volume is reduced while temperatures in the reactor remain high which could account for an increase in THC destruction. When load is increased from 80 to 110 percent, the THC concentration rises (A-12). This effect might be due to a lag warm up of the UOB™ as gas flow is increased. The effect of load changes depends on the programming of the UOB™, which initiates load changes over a period of several minutes. More rapid load changes are not required for industrial hydrogen applications. Gas compositions remained constant during steady state operation (A-13).

The results of CEM measurements for different process conditions and load changes are summarized on pages A-14 though A-20.

3.2 Hydrocarbon Speciation

Samples were collected using stainless steel and/or Teflon™ tubing in a 6-L SUMMA® canister. The canisters were cleaned and evacuated to a vacuum of negative 30 inches Hg (gauge) by the laboratory prior to sampling. The sample flow rate is regulated using a critical orifice that is calibrated in the laboratory prior to the field test.

Samples were collected over a 20-minute period. Because high sample gas moisture content was expected at each sample location, a moisture knock-out was placed directly upstream of the SUMMA® canister to protect the critical orifice and canister apparatus where necessary. Condensate was recovered following each test and stored in a sample container. USEPA Method TO-14, used to determine the concentration of hydrocarbon compounds, was modified to collect process or exhaust gas from stationary sources. HC species collected in the sample canisters were analyzed by GC/MS (gas chromatography/ mass spectroscopy) techniques. Gas compositions were also determined using ASTM Method D-1945. Analyses were performed with GC/FID (gas chromatograph/ flame ionization detector) techniques. This analysis provided CO₂, CO, nitrogen, oxygen, and hydrocarbons that are typically found in natural gas.

The analyses of the SUMMA® canister contents and the formaldehyde concentrations were performed by Air Toxics of Folsom, California.

The results of the HC speciation analyses are shown in Attachment D. The reportable limit for these analyses varies with each sample as the amount of dilution that is required for the SUMMA® canisters depends on how much each canister is filled. Ethane, propane, butane, pentane levels were below the reportable limit of 20 ppm for the ASTM-1945 method. These levels of non-methane hydrocarbons were lower than expected. Traces of other components at the part per billion (ppb) level were measured with the TO-14 analysis for the flare exhaust and product gas. Traces of benzene, toluene, xylene, and ethanol were observed in some of the samples. The levels were on the order to 1 to 10 ppb. In instances where the measurements are close to the reportable limit, the presence of the compound may be in question.

3.3 Ammonia and Moisture Determination

NH₃ emissions were measured following BAAQMD Method ST-1B. Sample gas was drawn through a series of 2 impingers containing 0.1 N hydrochloric acid at a rate of 0.5 cubic feet per minute (CFM) for approximately 30 minutes. Solution from each impinger was recovered and analyzed separately according to BAAQMD Analytical Procedure Lab-1 (spectrophotometry). Tare and final weights of each impinger were recorded for each test to estimate sample gas moisture content per USEPA Method 4. Sample flows were adjusted to accommodate variable NH₃ concentration levels with a minimum detection limit of 1 ppm. In addition to NH₃, the samples were also tested for total organic carbon. The analysis of the NH₄⁺ and condensate samples were performed by Sequoia Analytical Laboratory, Redwood City, California. Results are shown in Attachment C.

3.4 Formaldehyde

Formaldehyde concentrations in the sample gas were measured according to USEPA Method TO-11 using an adsorbent cartridge packed with 2,4 dinitrophenylhydrazine (DNPH). Because concentration levels are expected to reach ppm levels, samples were collected at a flow rate of 0.5 liters per minute over a 5 minute test period. The amount of formaldehyde adsorbed onto the DNPH was determined using high performance liquid chromatography (HPLC) following extraction. Sample flow was adjusted to accommodate variable HCHO concentration levels with a minimum detection limit of 1 ppm. Results are shown in Attachment B.

4. FUEL PROPERTIES

Fuel used for this testing was pipeline natural gas. The fuel properties in Table 8 have been assumed for the calculation of the system performance parameters.

Table 8. Fuel properties*

Parameter	Value
Composition	CH _{3.85} O _{0.019} N _{0.031}
HHV	52.3 (MJ/kg)
Molecular Weight	16.2 (g/mol)

*Unnasch, S., "Evaluation of Fuel Cycle Emissions on a Reactivity Basis," prepared under ARB Contract A166-134, September 1996.

5. REFERENCES

60 CFR 120:1444, "Method 18 - Measurement of Gaseous Organic Compound Emissions by Gas Chromatography," U.S. EPA, May 1996.

60 CFR 120:1044, "Method 4 - Determination of Moisture Content in Stack Gases," U.S. EPA, December 1995.

ARB Method 100, "Method 100, Procedures for Continuous Gaseous Emission Stack Sampling," California Air Resources Board, Amended July 28, 1997.

ASTM D 1945-81, "Standard Method for Analysis of Natural Gas by Gas Chromatography," Annual Book of ASTM Standards, Approved June 1981.

BAAQMD ST-1B, "Source Test Procedure ST-1B, Ammonia Integrated Sampling," Bay Area Air Quality Management District, Adopted January 1982.

U.S. EPA TO-11, "Compendium Method TO-11, Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography," Environmental Monitoring Systems Laboratory, Research Triangle Park, North Carolina, May 1988.

U.S. EPA TO-14, "Compendium Method TO-14, The Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Summa® Passivated Canister Sampling and Gas Chromatographic Analysis," Environmental Monitoring Systems Laboratory, Research Triangle Park, North Carolina, May 1988.

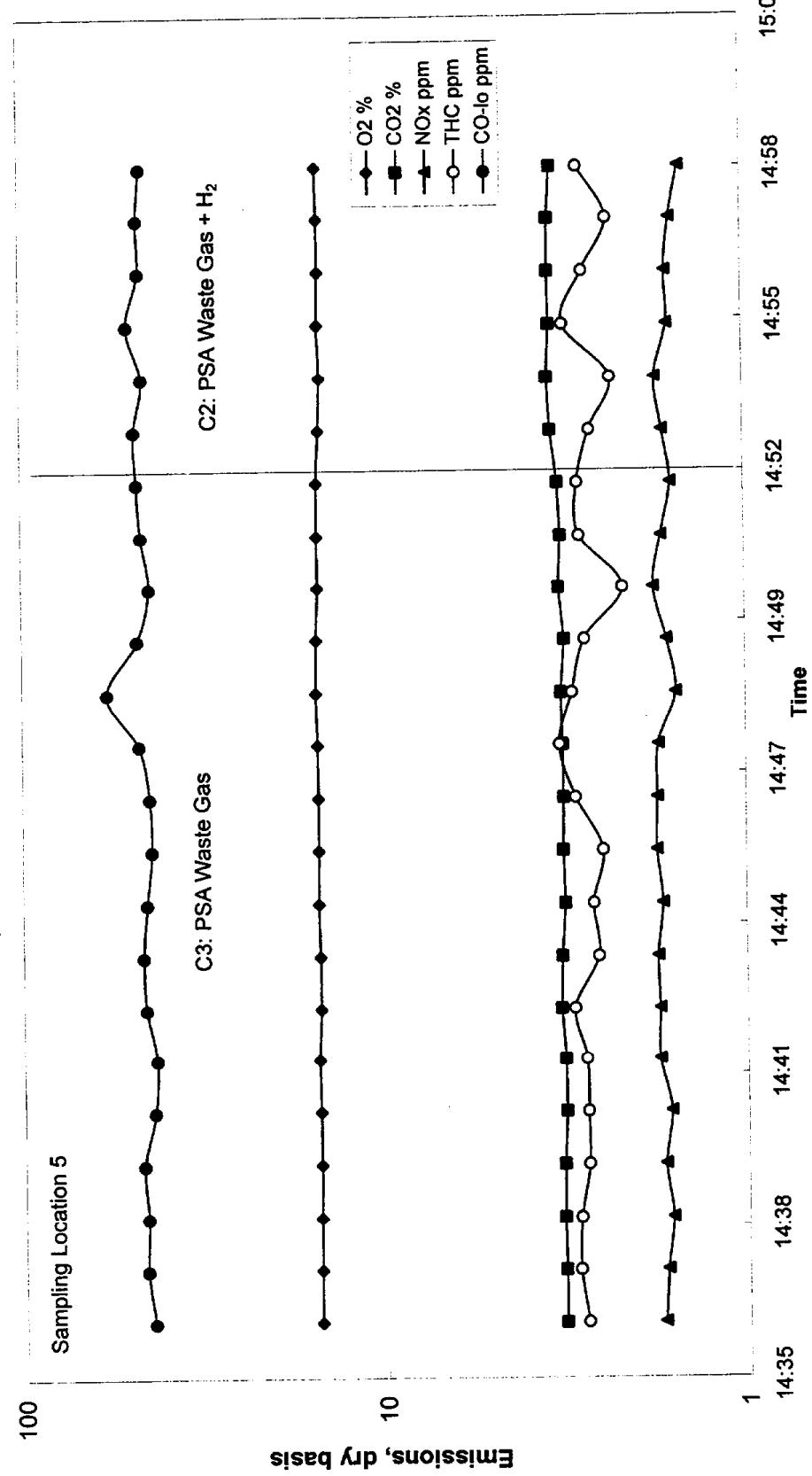
ATTACHMENT A. RESULTS OF CONTINUOUS EMISSION MONITORING

HBT UOB™ System

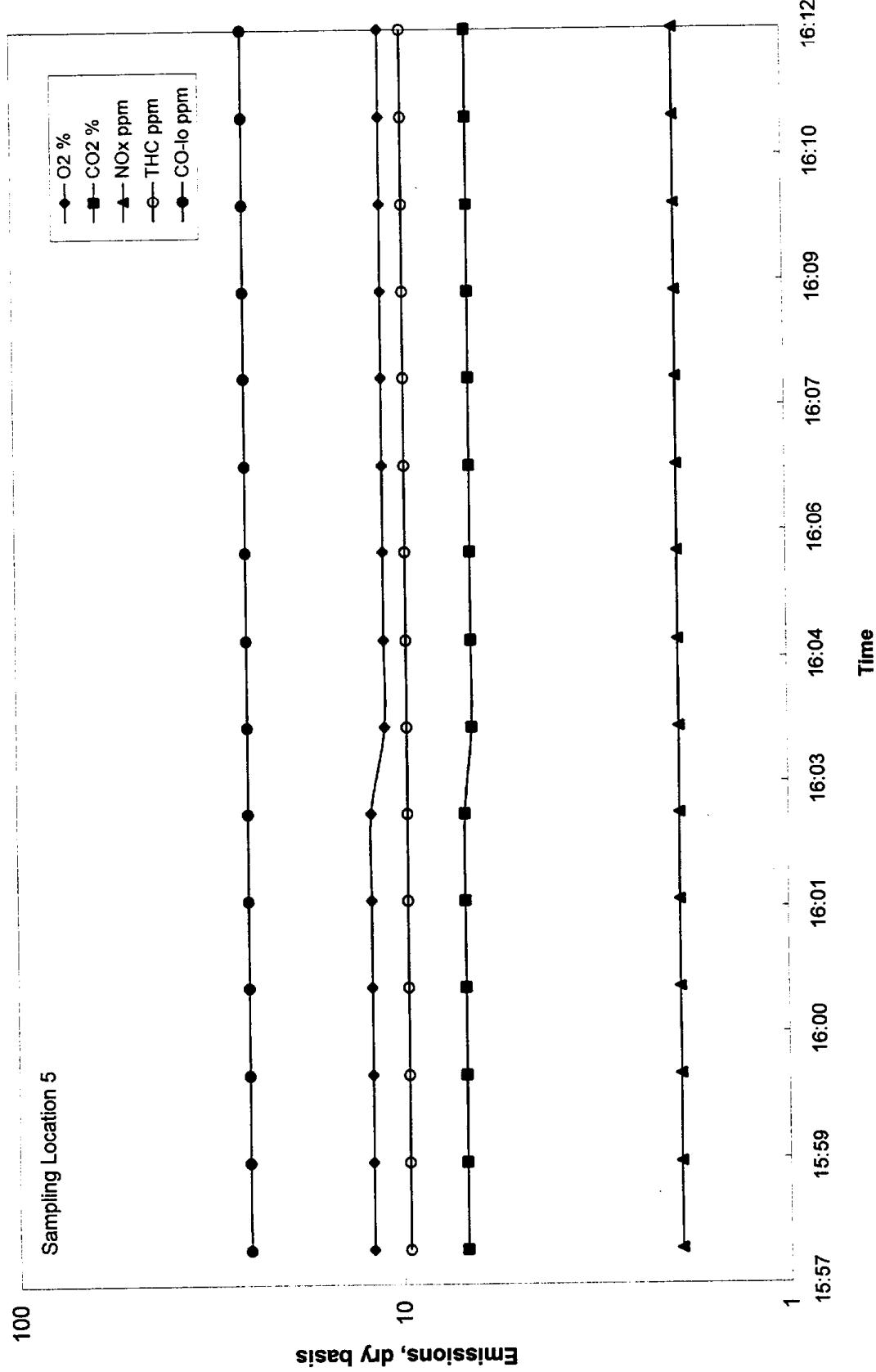
Table A-1. List of Figures and Sequence of Testing

Page	Date	Start	Sample Location	Key Value	Condition
A-3	1/7/98	14:36	5. Flare	THC, CO	C3: PSA waste gas, Full Load
A-3	1/7/98	14:52	5. Flare	THC, CO	C2: PSA waste gas + H ₂ , Full Load
A-4	1/7/98	15:58	5. Flare	THC, CO	C2: PSA waste gas + H ₂ , Full Load
A-5	1/8/98	8:25	5. Flare	THC, CO	Flare pilot only
A-6	1/8/98	8:49	5. Flare	THC, CO	POX pilot burner
A-7	1/8/98	11:19	5. Flare	THC, CO	Start of reforming, C2: all gases
A-8	1/8/98	12:45	1. POX after quench	THC, CO	Full Load
A-9	1/8/98	13:41	2: HTS exit	THC	Full Load
A-10	1/8/98	14:53	3. HTS after condenser	THC	Full Load
A-11	1/8/98	18:20	3. HTS after condenser	THC	Transient 100% to 80% Load
A-12	1/8/98	18:33	3. HTS after condenser	THC	Transient 80% to 110% Load
A-13	1/8/98	16:25	4. PSA waste gas	THC	Full Load
A-14	1/8/98	—	3. HTS after condenser	H ₂ + CO	Full Load
A-15	1/8/98	—	—	THC, CO	Various
A-16	1/8/98	—	—	THC	Various
A-17	1/8/98	—	—	THC, CO	Various
A-18	1/8/98	—	—	THC, CO	Various
A-19	1/8/98	—	—	HCHO, NH ₃	Various
A-20	1/8/98	—	5. Flare	THC reduction	Full Load, C2 and C3

Flare Emissions, PSA Waste Gas with and without H₂, Full Load



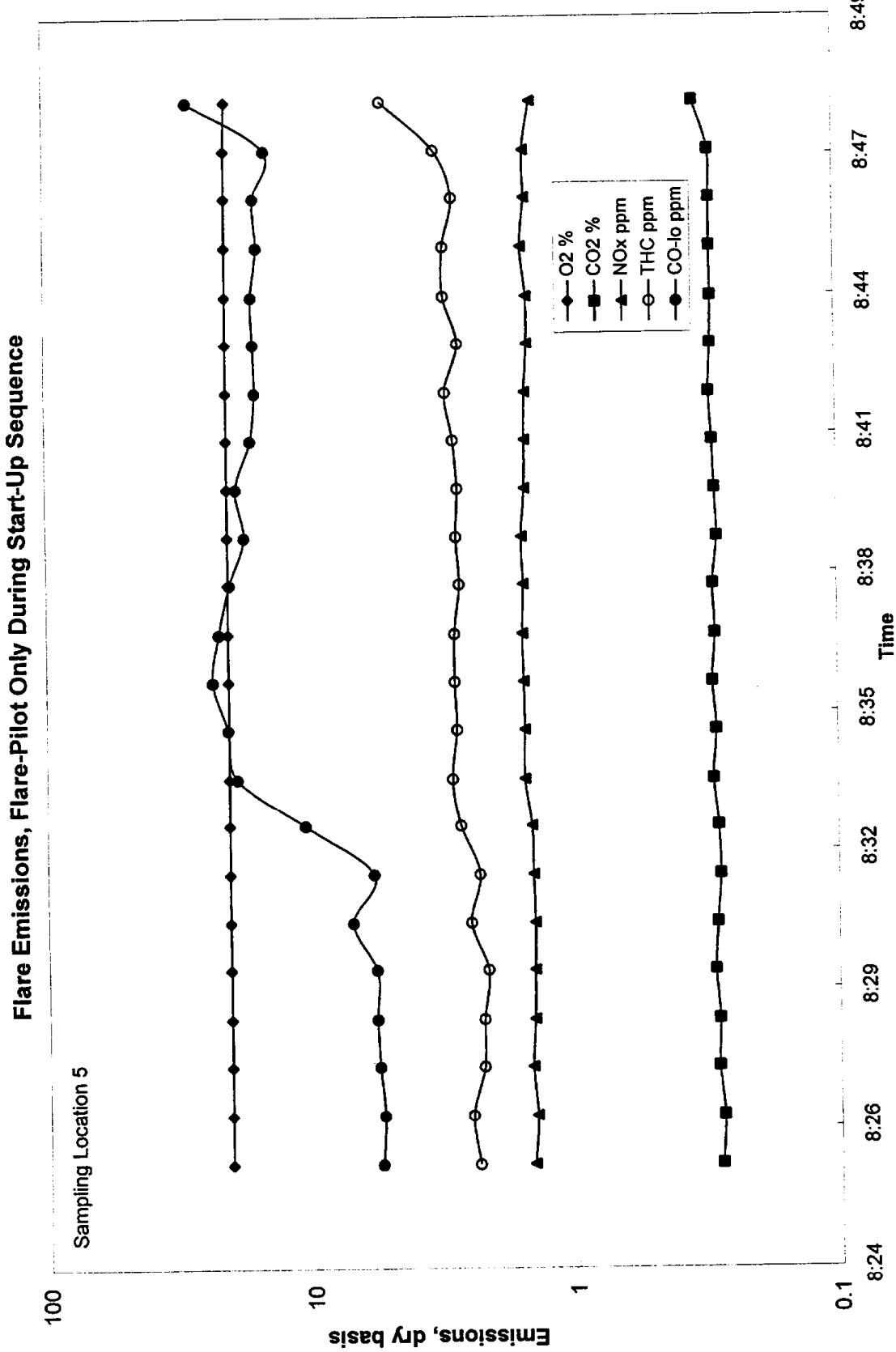
Flare Emissions, C2: PSA Waste Gas + H₂, Full Load



A-4

7 Jan 1998

Flare Chart 9

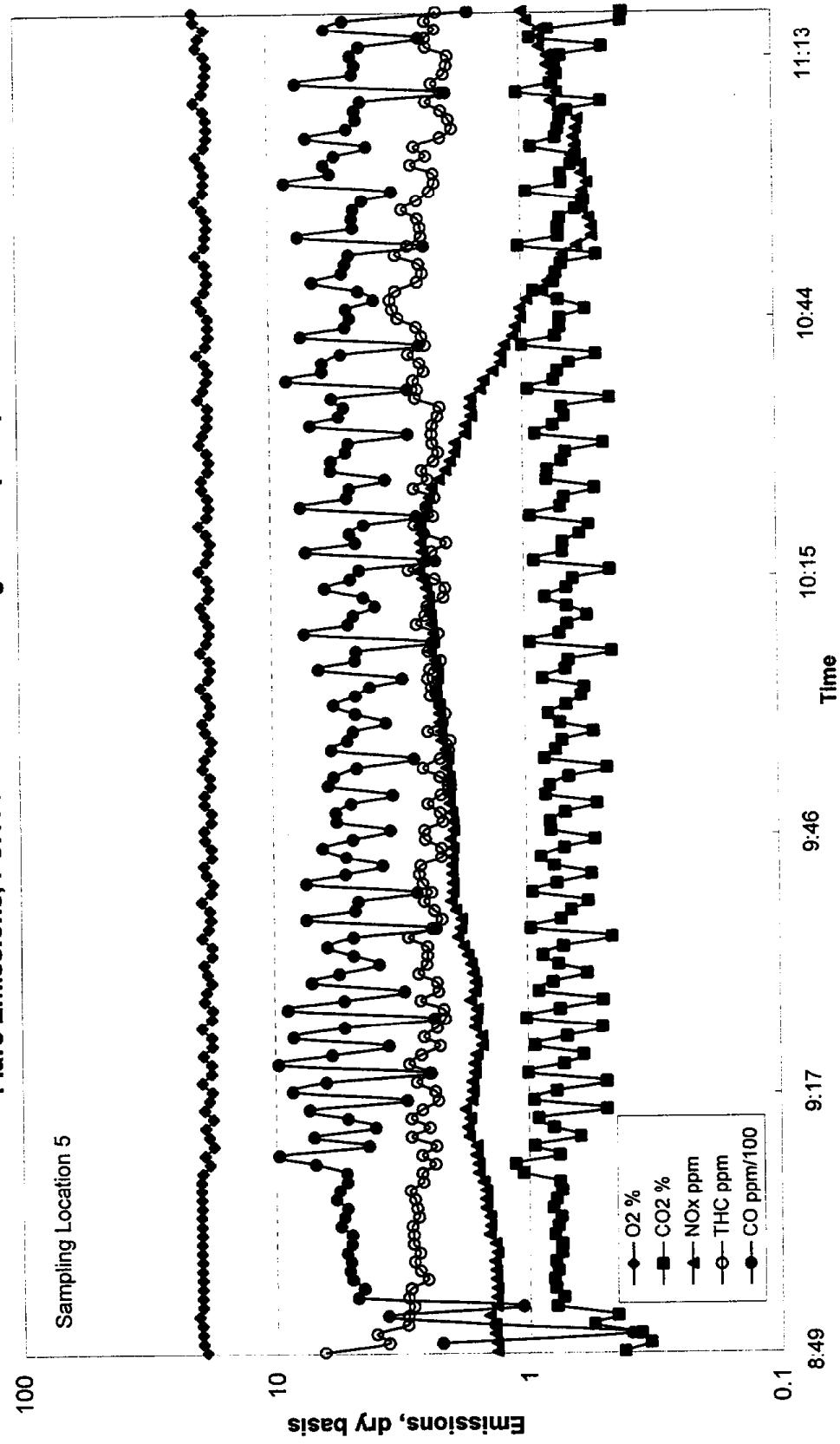


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8 Jan 1998

Flare Chart 5

Flare Emissions, POX Pilot Burner During Start-Up Sequence

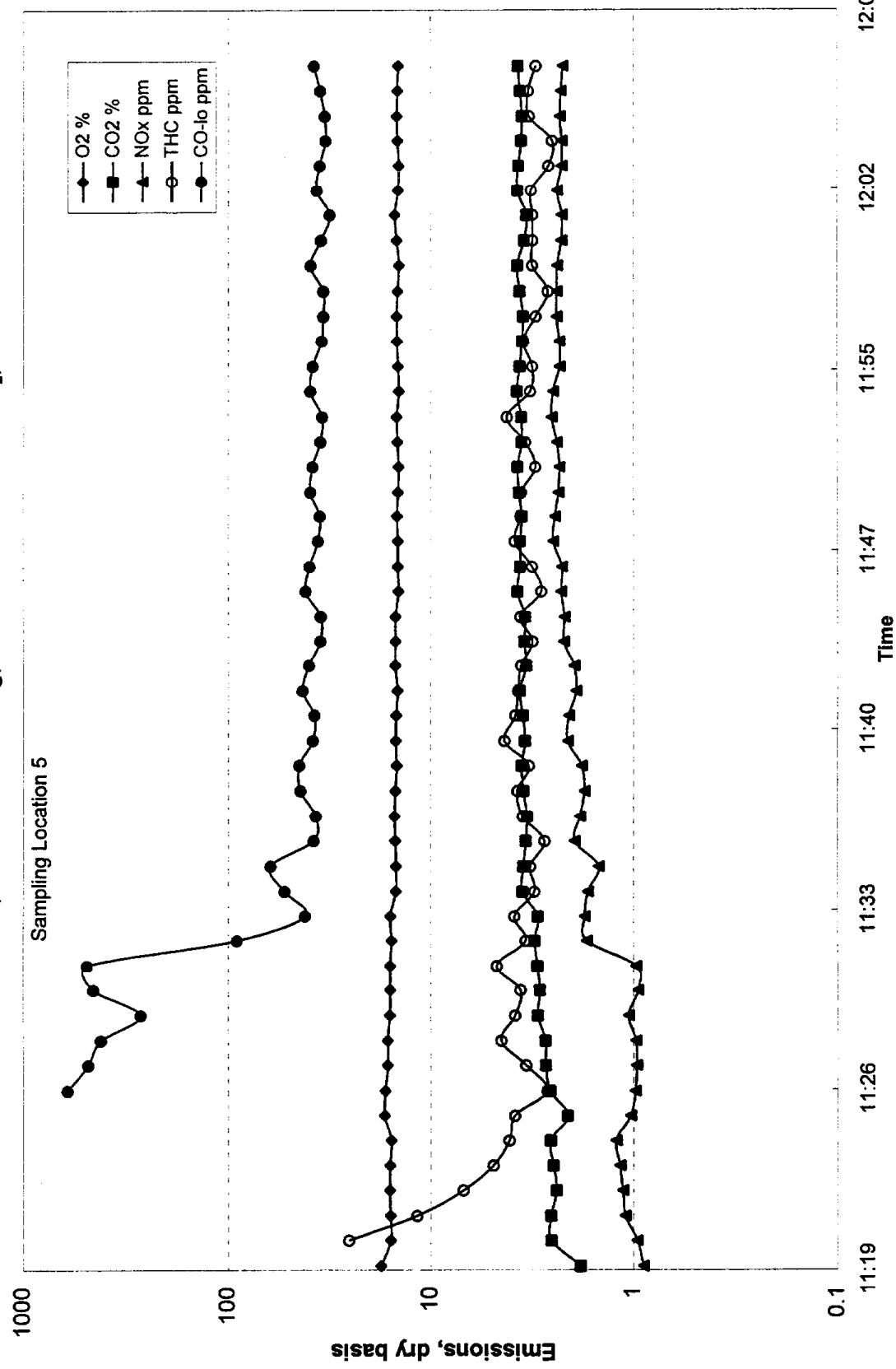


A-6

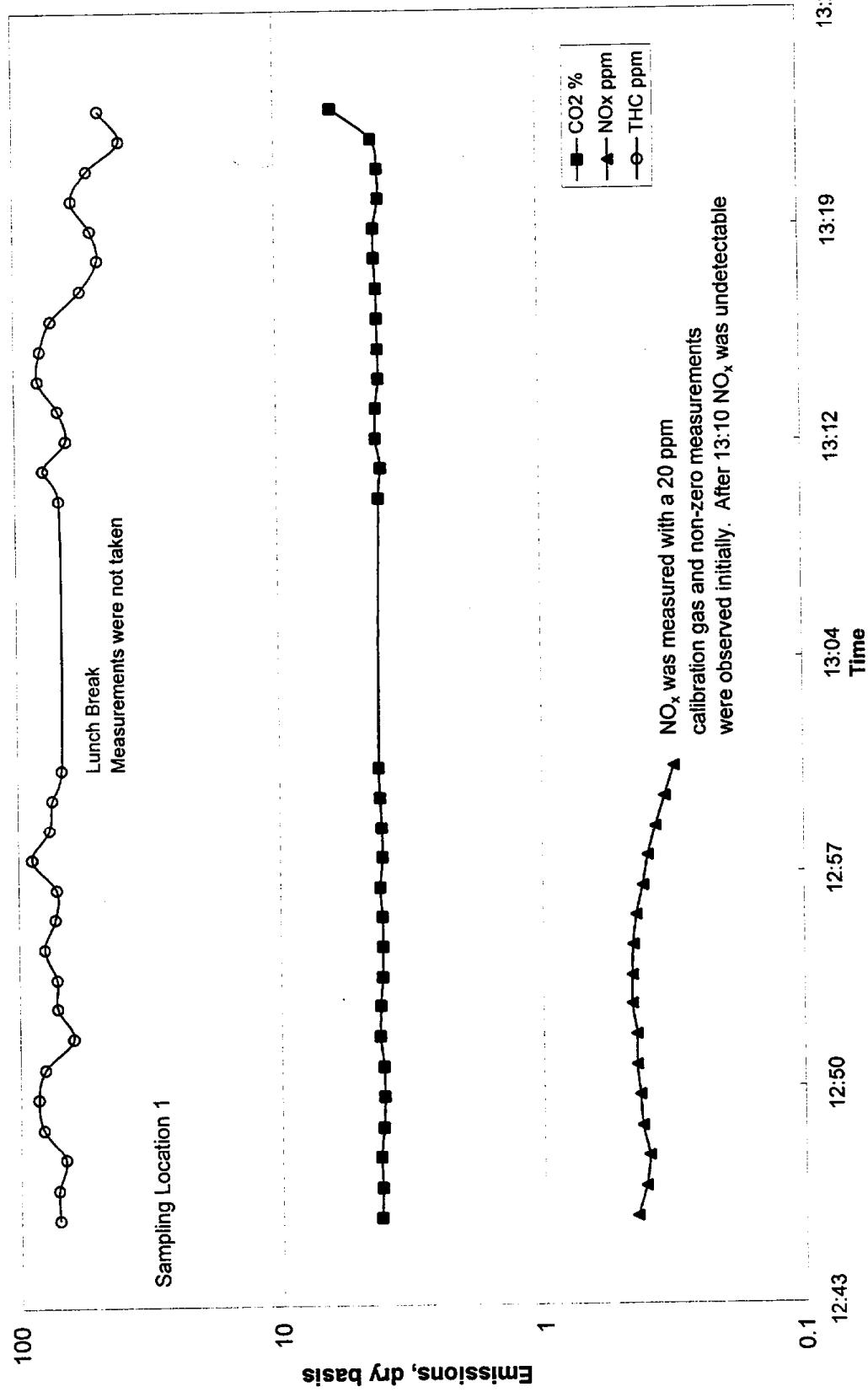
8 Jan 1998

Flare Chart 6

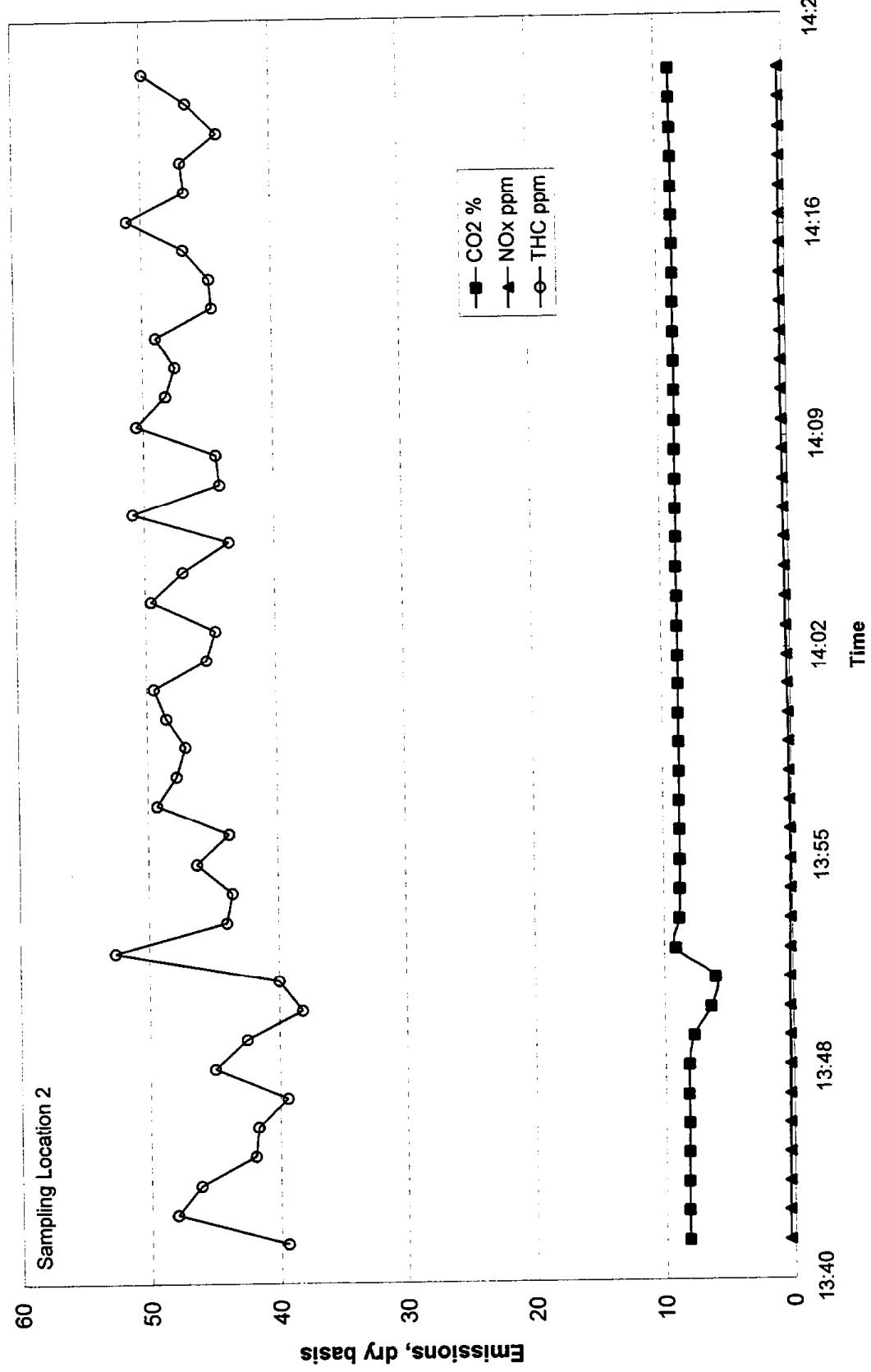
Flare Emissions, Start of Reforming, C2: PSA Waste Gas + H₂, Full Load



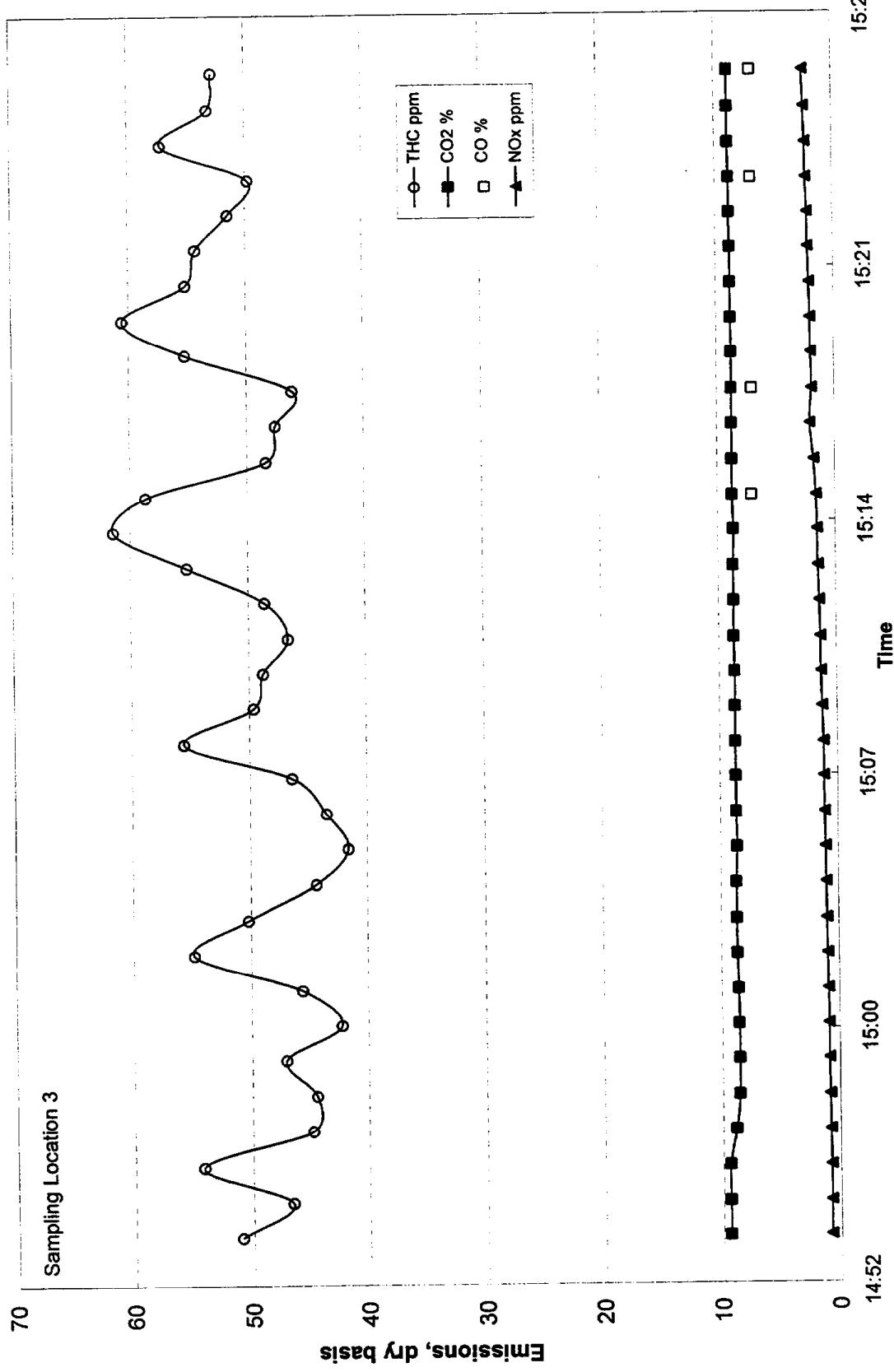
Product Gas Composition, POX after Quench, Full Load



Product Gas Composition, HTS Exit, Full Load



Product Gas Composition, HTS after Condenser, Full Load

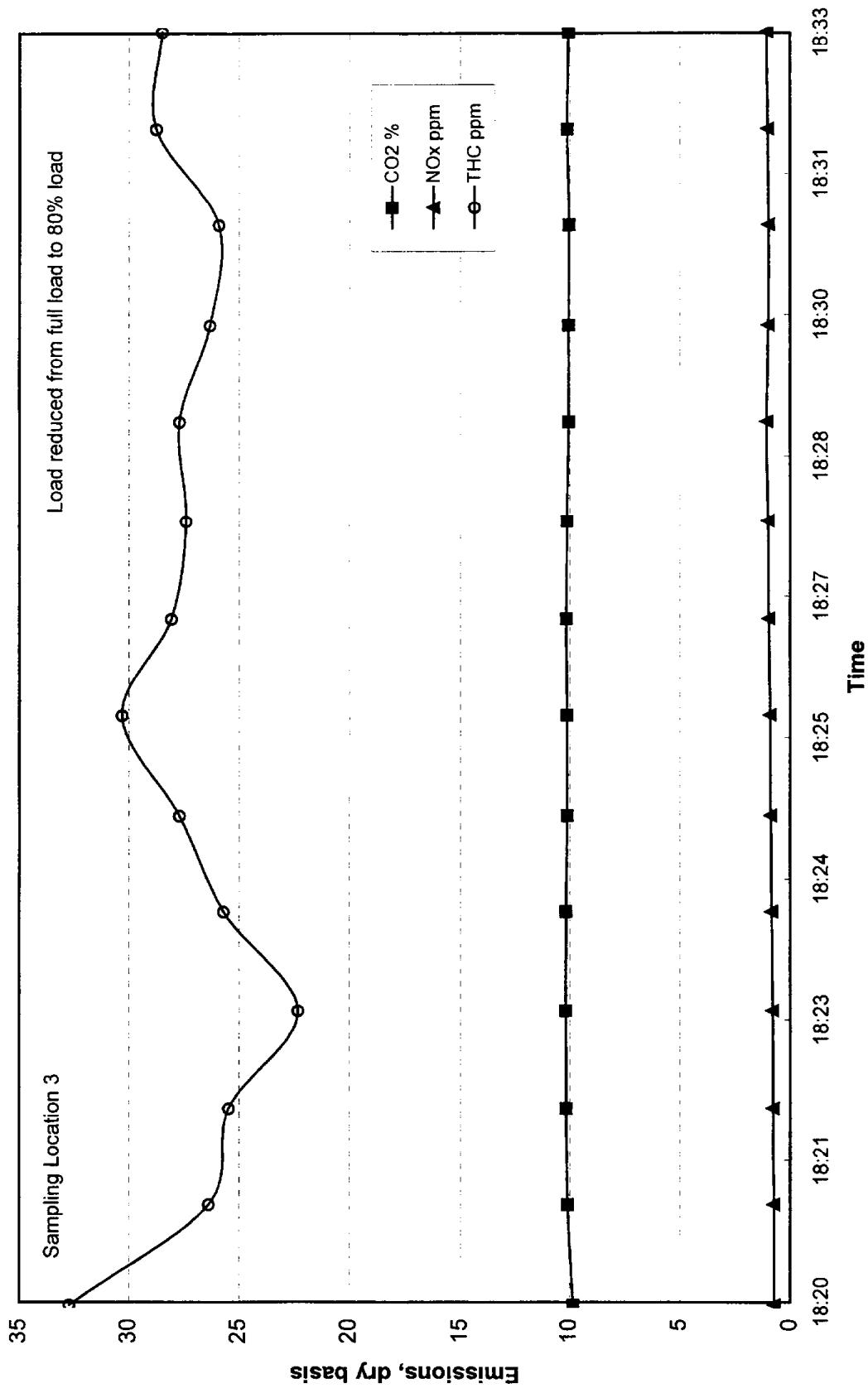


A-10

8 Jan 1998

HTS after Condenser Chart 2

Product Gas Composition, HTS after Condenser, 100% to 80%



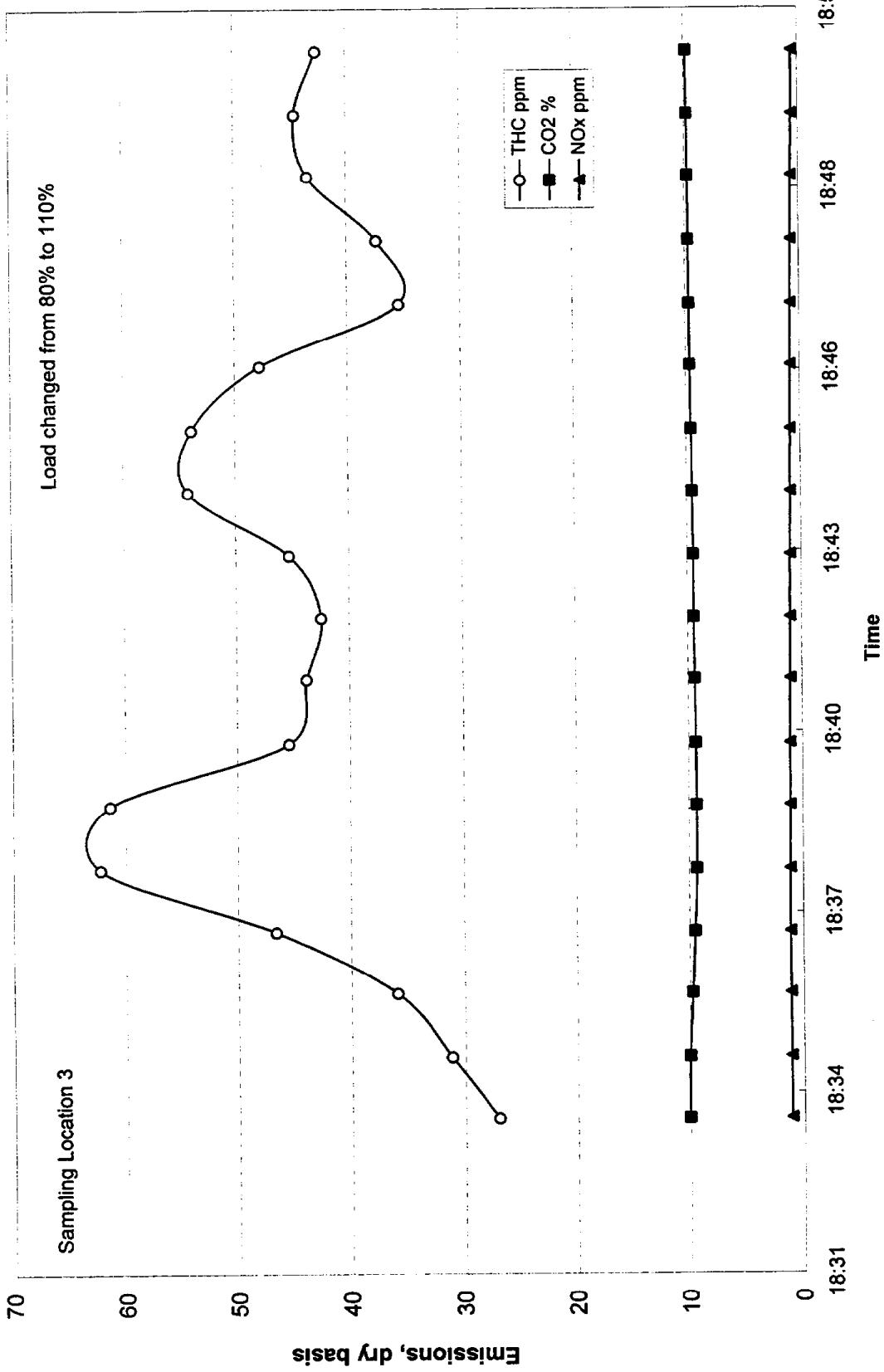
A-11

(Figure 5-14)

8 Jan 1998

HTS after Condenser Chart 4

Product Composition, HTS after Condenser, 80% to 110%

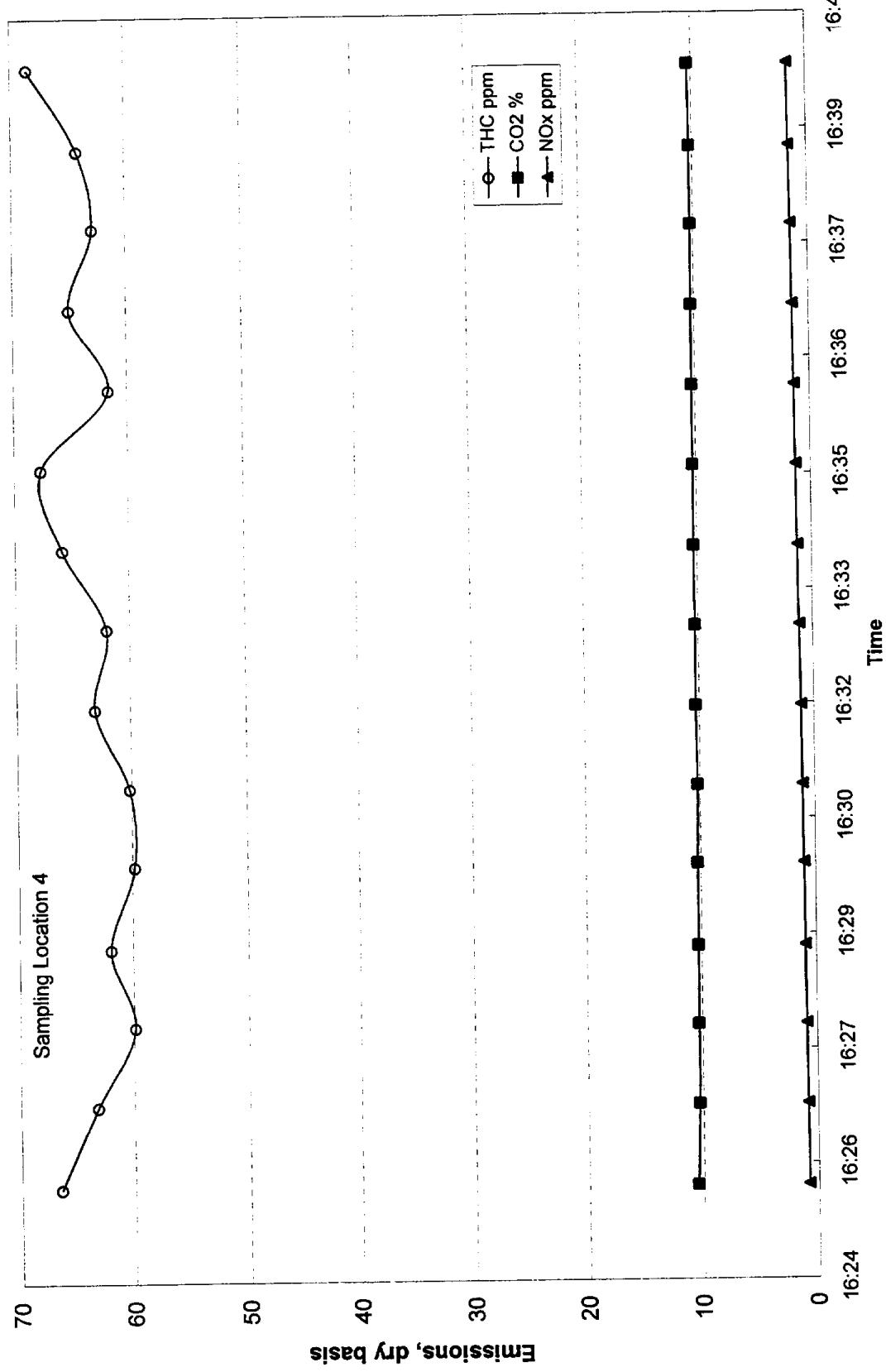


A-12 (Figure 5-14)

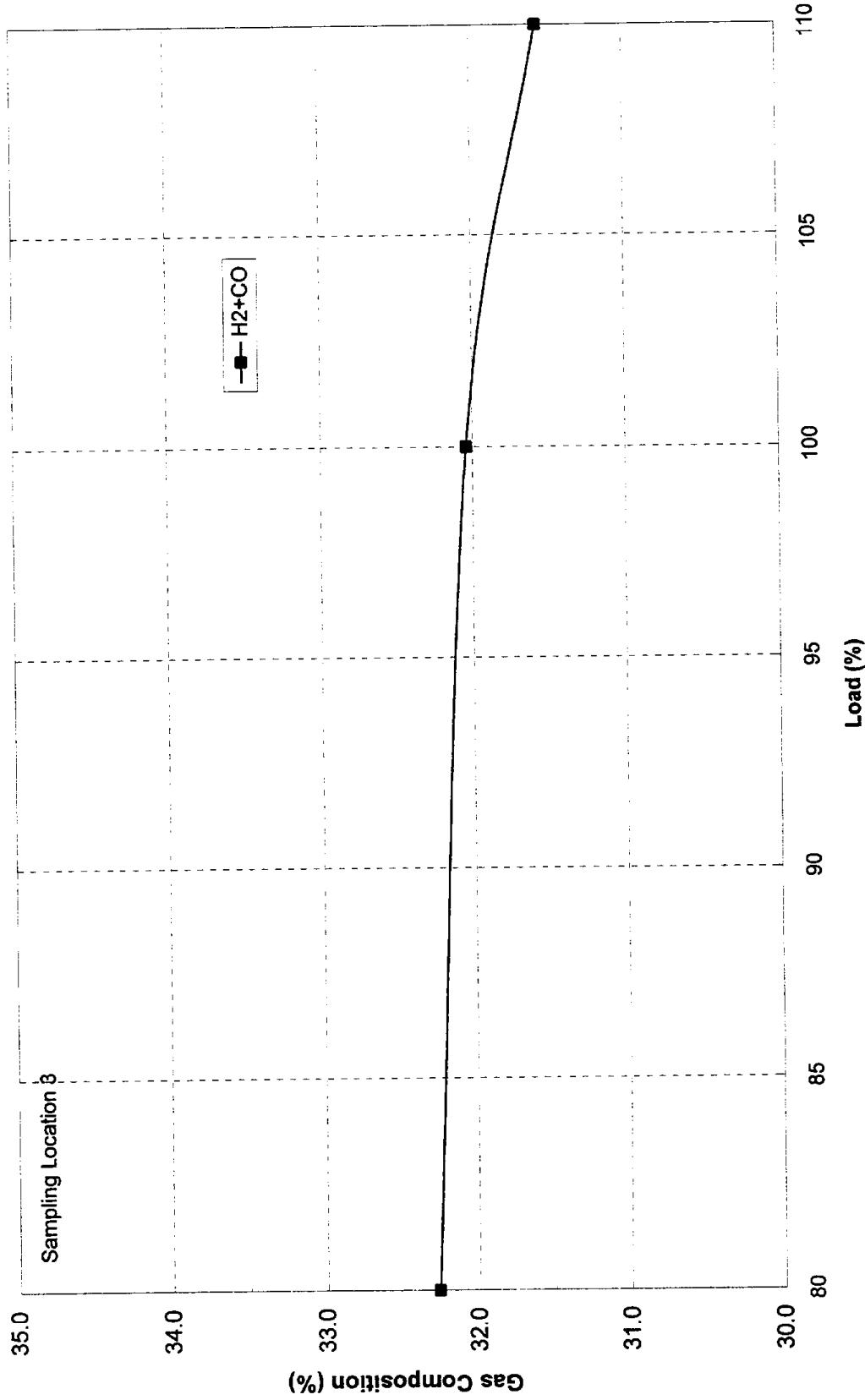
8 Jan 1998

HTS after Condenser Chart 6

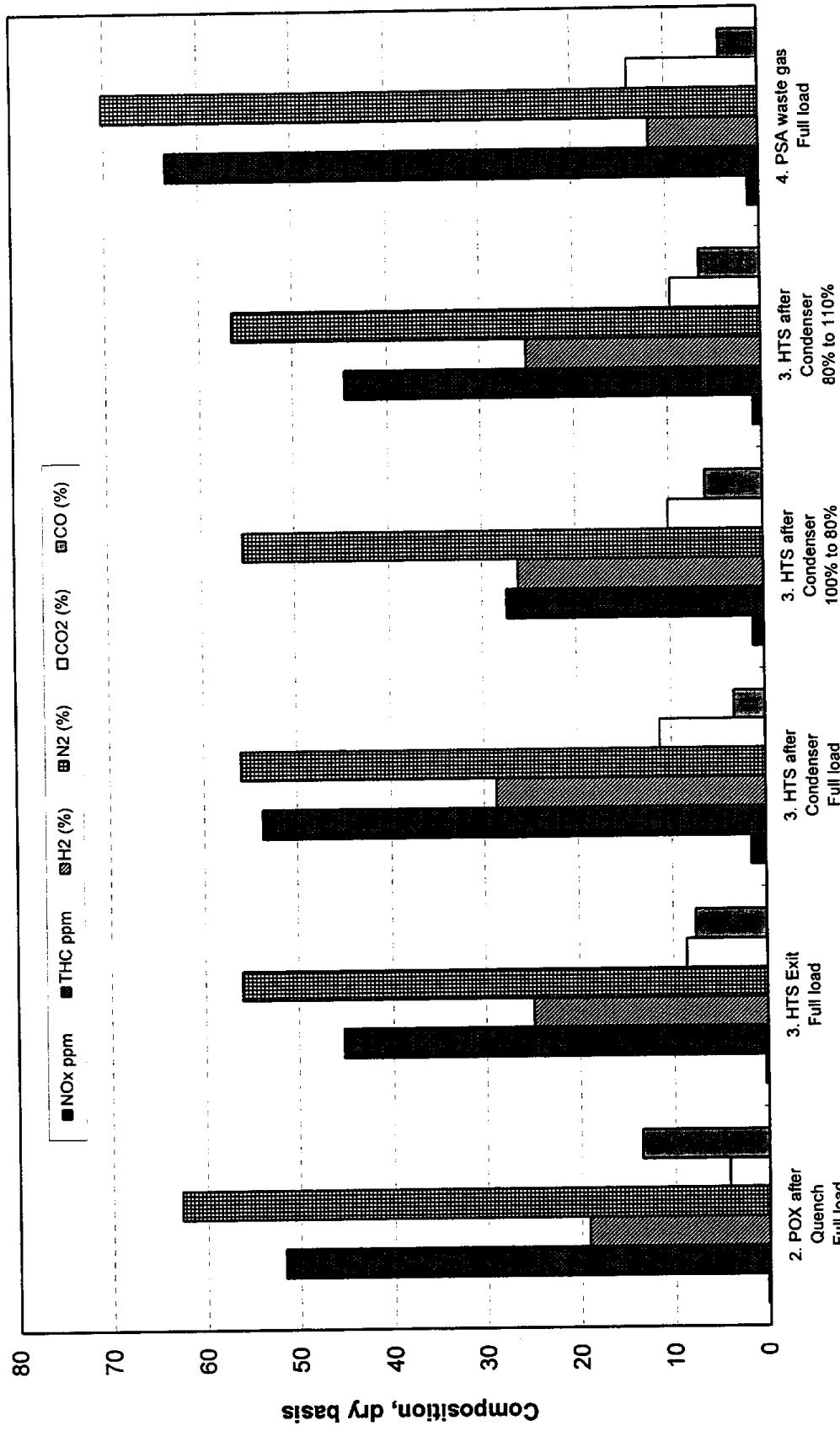
Product Gas Composition, PSA Waste Gas, Full Load



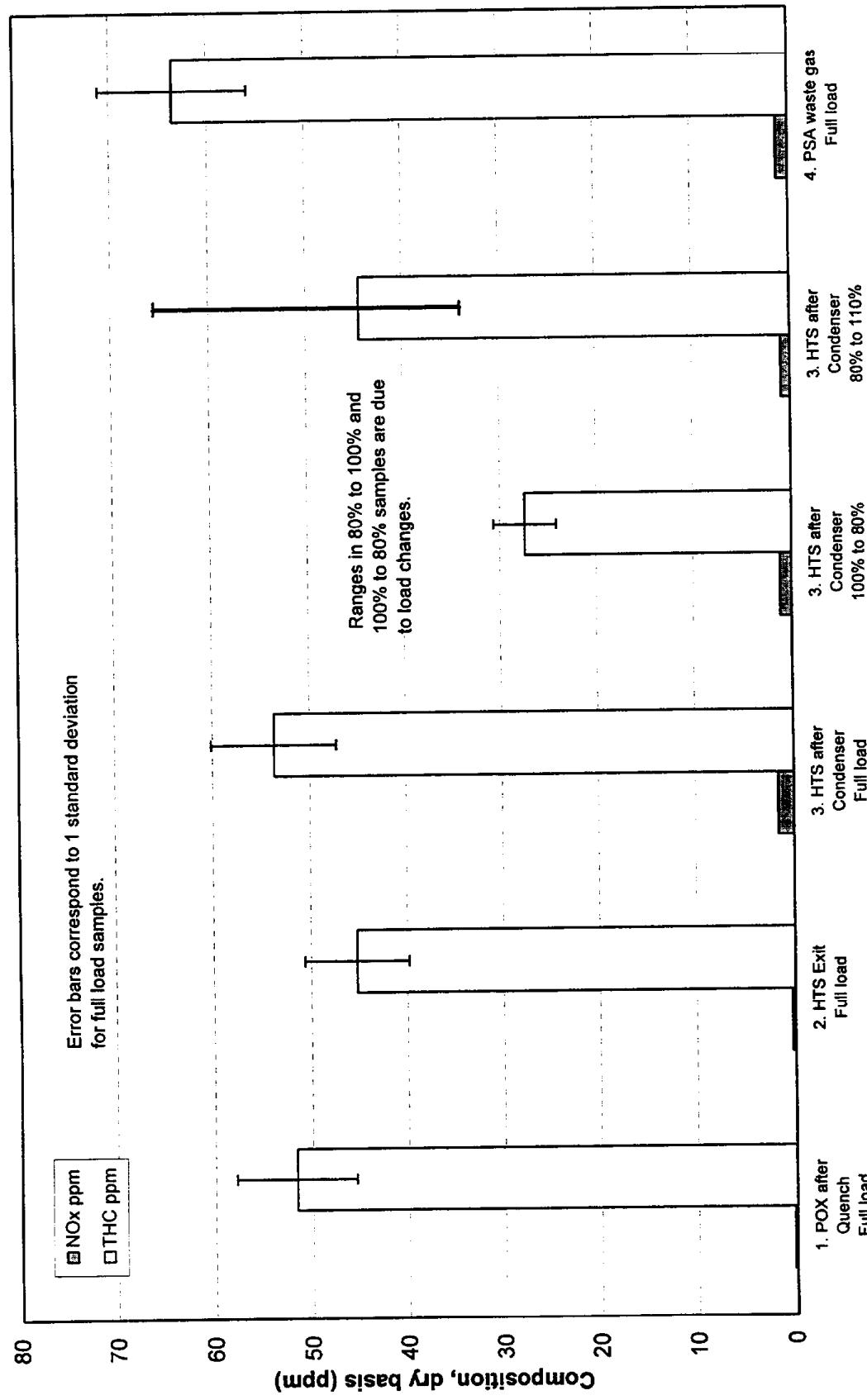
Effect of Transient Behavior on POX Output

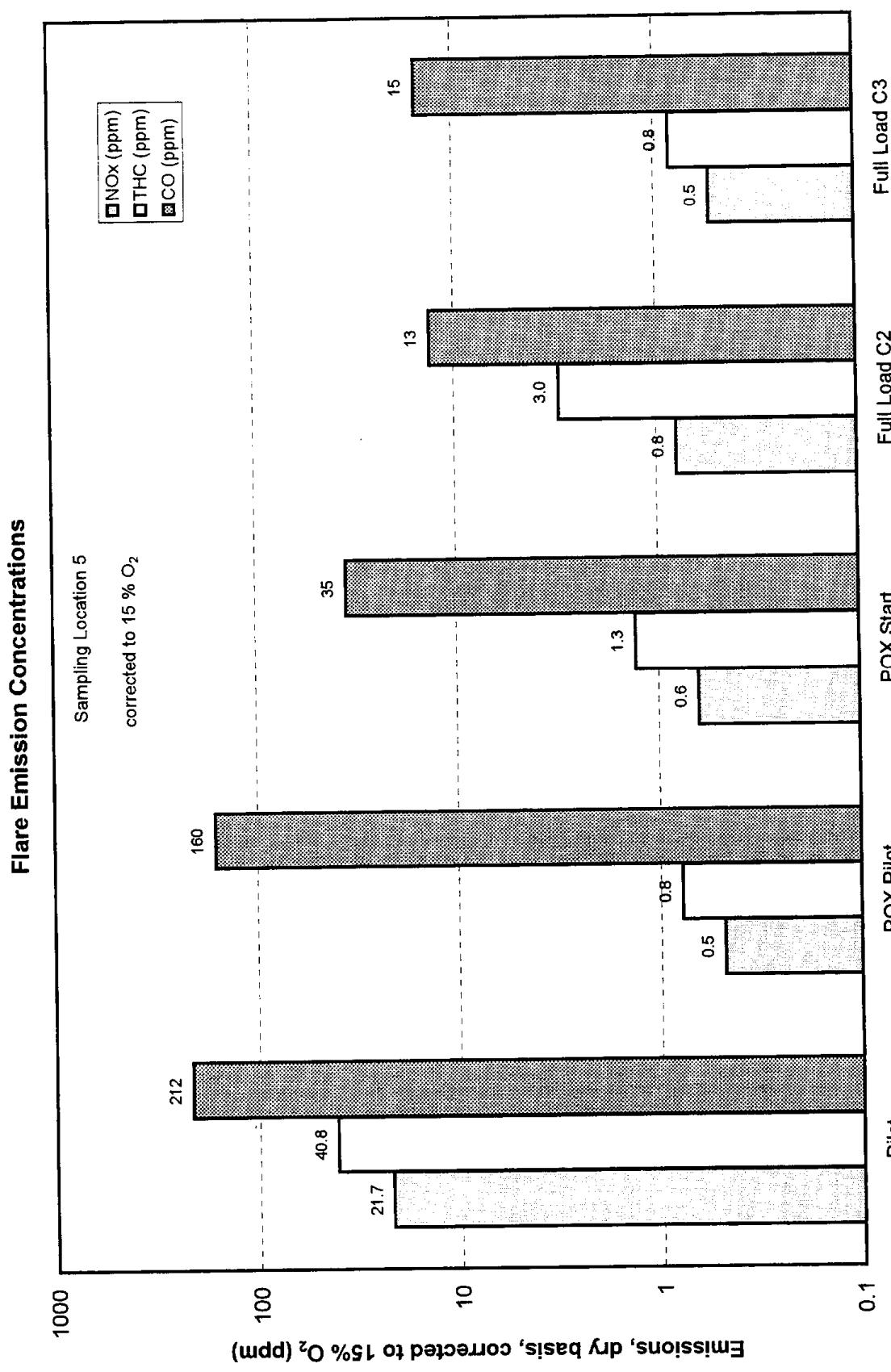


**Variation in Gas Composition with Sampling Location
and Load Changes**



Variation in THC and NO_x with Process Conditions and Load Changes

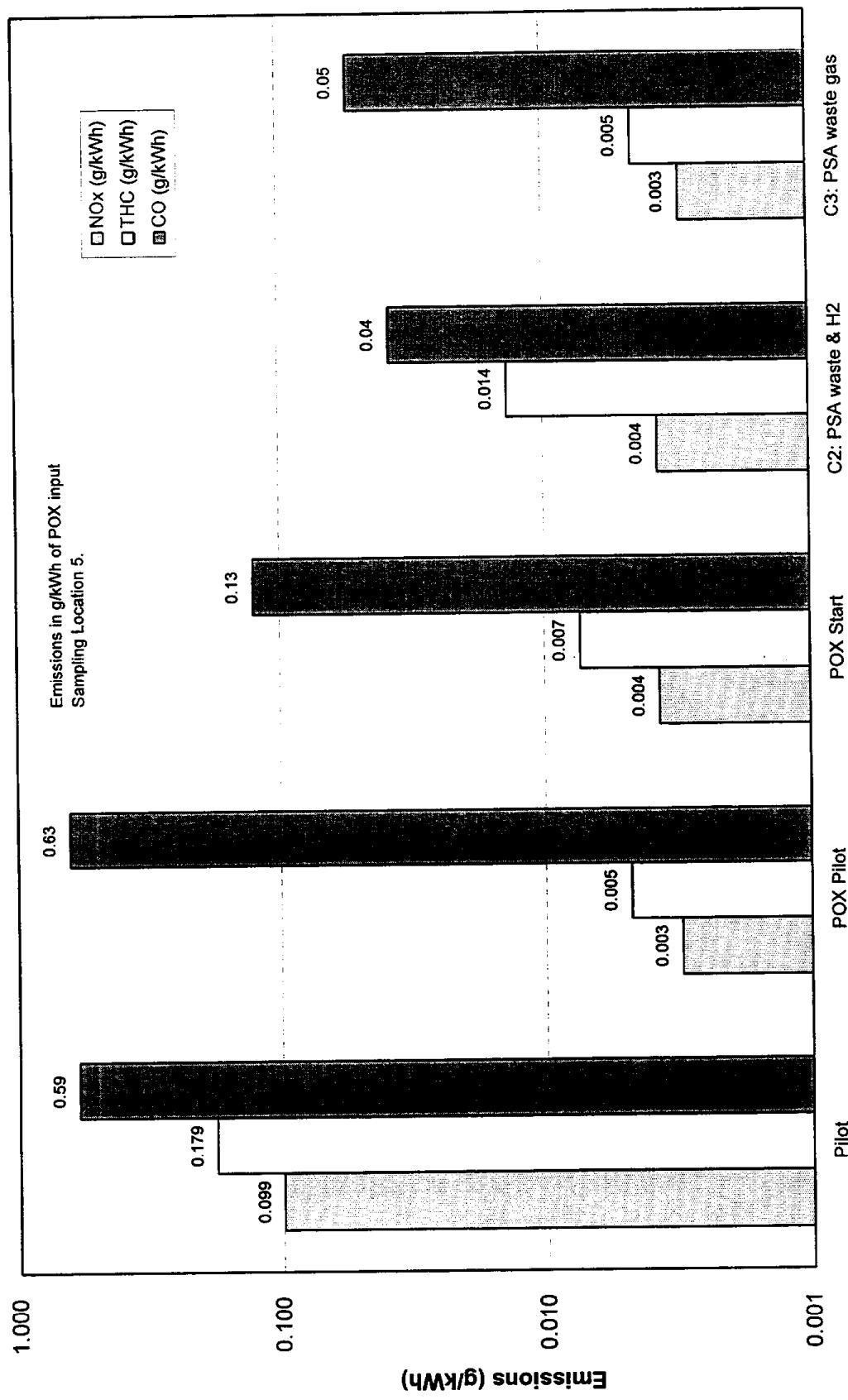




A-17 (Figure 5-12)

8 Jan 1998

Flare Emission Rates

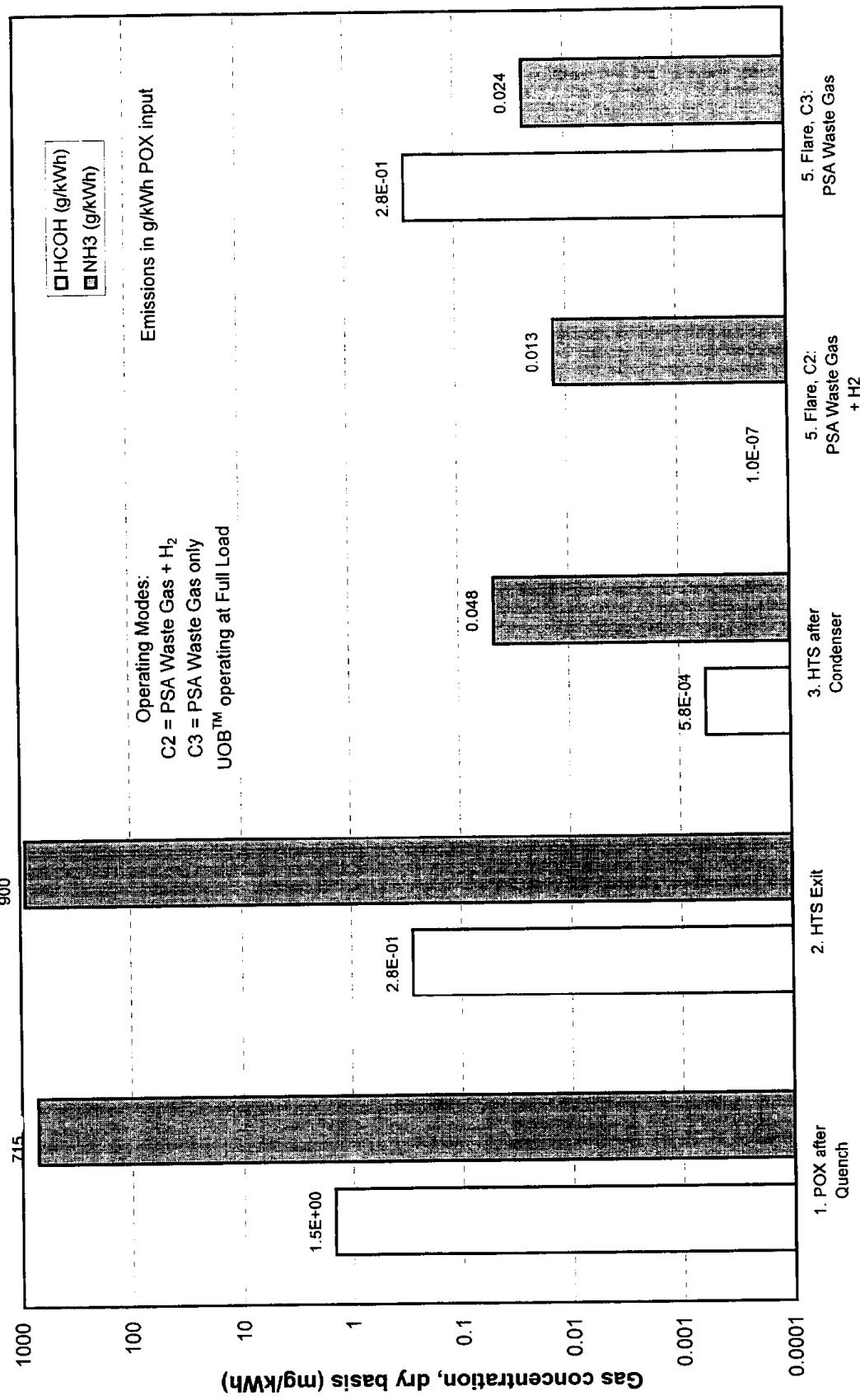


A-18 (Figure 5-13)

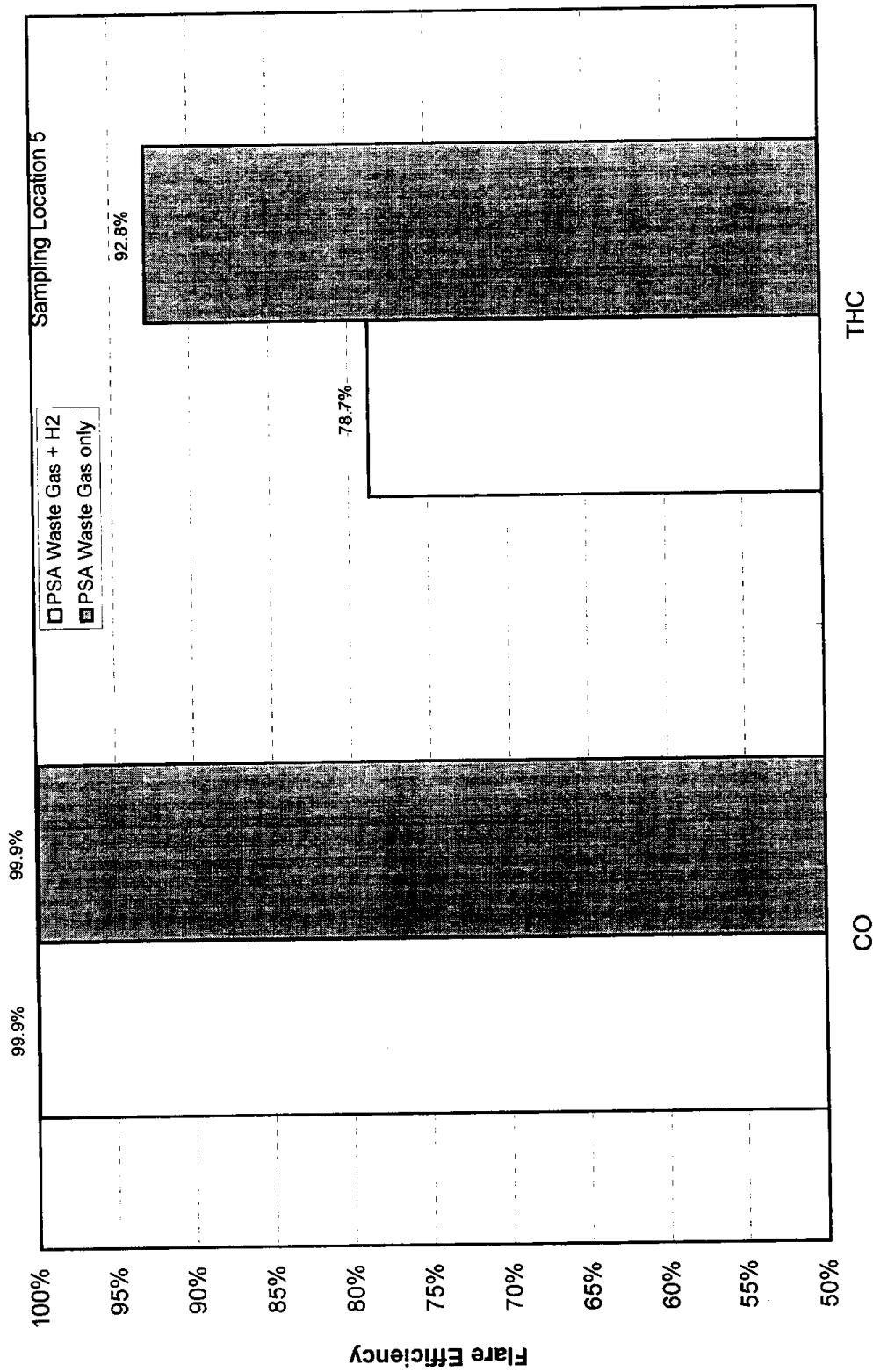
8 Jan 1998

Average Emissions Chart 30

Variation in Ammonia and Formaldehyde with Process Conditions



Effect of Product Gas Composition on Flare Efficiency



A-20 (Figure 5-15)

Operator: JC Plant Name: HBT Partial Oxidation Unit Location: Long Beach, CA

Date	Time	O2 %	CO2 %	NOx ppm	THC ppm	CO-lo ppm	Location	Condition
1/7/98	14:36	15.21	3.21	1.71	2.79	44.3	Flare	Full Load 3
1/7/98	14:37	15.20	3.22	1.68	2.93	46.26	Flare	Full Load 3
1/7/98	14:38	15.18	3.23	1.62	2.91	46.06	Flare	Full Load 3
1/7/98	14:39	15.18	3.23	1.69	2.76	47.11	Flare	Full Load 3
1/7/98	14:40	15.19	3.19	1.63	2.77	43.88	Flare	Full Load 3
1/7/98	14:41	15.26	3.20	1.75	2.79	43.22	Flare	Full Load 3
1/7/98	14:42	15.09	3.27	1.74	3.00	46.07	Flare	Full Load 3
1/7/98	14:43	15.11	3.25	1.76	2.56	46.78	Flare	Full Load 3
1/7/98	14:44	15.23	3.17	1.70	2.64	45.64	Flare	Full Load 3
1/7/98	14:45	15.20	3.21	1.76	2.48	44.17	Flare	Full Load 3
1/7/98	14:46	15.19	3.19	1.75	2.96	44.74	Flare	Full Load 3
1/7/98	14:47	15.21	3.21	1.74	3.27	47.7	Flare	Full Load 3
1/7/98	14:48	15.35	3.23	1.55	3.01	58.1	Flare	Full Load 3
1/7/98	14:49	15.29	3.16	1.64	2.77	48.02	Flare	Full Load 3
1/7/98	14:50	15.12	3.27	1.78	2.16	44.53	Flare	Full Load 3
1/7/98	14:51	15.15	3.22	1.69	2.85	46.68	Flare	Full Load 3
1/7/98	14:52	15.12	3.27	1.59	2.88	47.69	Flare	Full Load 2
1/7/98	14:53	14.90	3.41	1.67	2.65	48.41	Flare	Full Load 2
1/7/98	14:54	14.73	3.47	1.74	2.31	46.05	Flare	Full Load 2
1/7/98	14:55	14.90	3.41	1.61	3.13	50.37	Flare	Full Load 2
1/7/98	14:56	14.82	3.43	1.62	2.75	46.74	Flare	Full Load 2
1/7/98	14:57	14.83	3.43	1.57	2.35	47.08	Flare	Full Load 2
1/7/98	14:58	14.94	3.36	1.48	2.83	46.14	Flare	Full Load 2

Date	Time	O2 %	CO2 %	NOx ppm	THC ppm	CO-lo ppm	Location	Condition
1/7/98	15:58	12.00	6.80	1.90	9.60	25	Flare	Full Load 2
1/7/98	15:59	12.00	6.80	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:00	12.00	6.80	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:01	12.00	6.80	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:02	12.00	6.80	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:03	12.00	6.80	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:04	11.00	6.50	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:05	11.00	6.50	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:06	11.00	6.50	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:07	11.00	6.50	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:08	11.00	6.50	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:09	11.00	6.50	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:10	11.00	6.50	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:11	11.00	6.50	1.90	9.60	25	Flare	Full Load 2
1/7/98	16:12	11.00	6.50	1.90	9.60	25	Flare	Full Load 2

Date	Time	O2 %	CO2 %	NOx ppm	THC ppm	CO-lo ppm	Location	Condition
1/8/98	8:26	20.59	0.28	1.46	2.35	5.5	Flare	Start up 2 Flare Pilot only
1/8/98	8:27	20.60	0.28	1.42	2.49	5.4	Flare	Start up 2 Flare Pilot only
1/8/98	8:28	20.59	0.29	1.47	2.25	5.6	Flare	Start up 2 Flare Pilot only
1/8/98	8:29	20.59	0.29	1.44	2.24	5.7	Flare	Start up 2 Flare Pilot only
1/8/98	8:30	20.58	0.30	1.43	2.15	5.7	Flare	Start up 2 Flare Pilot only
1/8/98	8:31	20.58	0.29	1.42	2.49	7	Flare	Start up 2 Flare Pilot only
1/8/98	8:32	20.60	0.28	1.44	2.3	5.8	Flare	Start up 2 Flare Pilot only
1/8/98	8:33	20.60	0.29	1.46	2.71	10.6	Flare	Start up 2 Flare Pilot only

1/8/98	8:34	20.59	0.30	1.54	2.9	19.2	Flare	Start up 2	Flare Pilot only
1/8/98	8:35	20.59	0.29	1.53	2.78	20.7	Flare	Start up 2	Flare Pilot only
1/8/98	8:36	20.59	0.30	1.54	2.83	23.6	Flare	Start up 2	Flare Pilot only
1/8/98	8:37	20.60	0.29	1.56	2.82	22.3	Flare	Start up 2	Flare Pilot only
1/8/98	8:38	20.60	0.29	1.54	2.7	20.3	Flare	Start up 2	Flare Pilot only
1/8/98	8:39	20.61	0.28	1.56	2.77	17.8	Flare	Start up 2	Flare Pilot only
1/8/98	8:40	20.61	0.29	1.52	2.73	19.1	Flare	Start up 2	Flare Pilot only
1/8/98	8:41	20.61	0.29	1.51	2.82	16.7	Flare	Start up 2	Flare Pilot only
1/8/98	8:42	20.60	0.30	1.50	3.01	16	Flare	Start up 2	Flare Pilot only
1/8/98	8:43	20.61	0.30	1.46	2.69	16.2	Flare	Start up 2	Flare Pilot only
1/8/98	8:44	20.61	0.29	1.47	3.03	16.4	Flare	Start up 2	Flare Pilot only
1/8/98	8:45	20.61	0.29	1.53	3.03	15.6	Flare	Start up 2	Flare Pilot only
1/8/98	8:46	20.60	0.29	1.48	2.79	16	Flare	Start up 2	Flare Pilot only
1/8/98	8:47	20.61	0.30	1.49	3.26	14.5	Flare	Start up 2	Flare Pilot only
1/8/98	8:48	20.40	0.34	1.40	5.18	28.3	Flare	Start up 2	Flare Pilot only

Date	Time	O2 %	CO2 %	NOx ppm	THC ppm	CO-lo ppm	Location	Condition
1/8/98	8:49	19.01	0.42	1.36	6.49	222.8	Flare	Start up 2
1/8/98	8:50	19.68	0.33	1.37	3.62	39.6	Flare	Start up 2
1/8/98	8:51	19.83	0.36	1.39	4.05	138.5	Flare	Start up 2
1/8/98	8:52	19.86	0.56	1.38	3.05	362.5	Flare	Start up 2
1/8/98	8:53	20.38	0.45	1.46	3.04	106.2	Flare	Start up 2
1/8/98	8:54	19.74	0.78	1.36	2.88	476.9	Flare	Start up 2
1/8/98	8:55	19.81	0.73	1.36	3.02	451.5	Flare	Start up 2
1/8/98	8:56	19.76	0.79	1.36	2.96	501.2	Flare	Start up 2
1/8/98	8:57	19.76	0.80	1.37	2.53	514.9	Flare	Start up 2
1/8/98	8:58	19.79	0.77	1.37	2.71	507.8	Flare	Start up 2
1/8/98	8:59	19.79	0.79	1.39	2.86	526.8	Flare	Start up 2
1/8/98	9:00	19.84	0.75	1.35	2.72	504.6	Flare	Start up 2
1/8/98	9:01	19.85	0.74	1.38	2.89	502.3	Flare	Start up 2
1/8/98	9:02	19.78	0.79	1.45	2.88	556.3	Flare	Start up 2
1/8/98	9:03	19.82	0.77	1.43	2.92	538.5	Flare	Start up 2
1/8/98	9:04	19.85	0.75	1.44	2.74	523.1	Flare	Start up 2
1/8/98	9:05	19.77	0.80	1.50	2.79	578.6	Flare	Start up 2
1/8/98	9:06	19.81	0.78	1.49	2.84	561.9	Flare	Start up 2
1/8/98	9:07	19.88	0.74	1.49	2.96	522.7	Flare	Start up 2
1/8/98	9:08	19.85	0.75	1.53	2.63	525.8	Flare	Start up 2
1/8/98	9:09	19.56	1.05	1.59	2.65	697.9	Flare	Start up 2
1/8/98	9:10	18.27	1.13	1.59	2.35	971.4	Flare	Start up 2
1/8/98	9:11	19.13	0.76	1.62	2.65	428.8	Flare	Start up 2
1/8/98	9:12	17.62	0.95	1.61	2.33	704.8	Flare	Start up 2
1/8/98	9:13	18.36	0.63	1.73	2.92	402.9	Flare	Start up 2
1/8/98	9:14	18.99	0.79	1.75	2.47	517.7	Flare	Start up 2
1/8/98	9:15	17.73	0.91	1.71	2.92	733.8	Flare	Start up 2
1/8/98	9:16	19.15	0.49	1.79	2.64	302.5	Flare	Start up 2
1/8/98	9:17	18.34	0.95	1.69	2.28	857.8	Flare	Start up 2
1/8/98	9:18	17.83	0.77	1.66	2.34	630.1	Flare	Start up 2
1/8/98	9:19	19.51	0.49	1.67	2.77	245.9	Flare	Start up 2
1/8/98	9:20	17.95	1.00	1.63	2.43	972.2	Flare	Start up 2
1/8/98	9:21	17.95	0.72	1.63	2.96	595.7	Flare	Start up 2
1/8/98	9:22	19.32	0.60	1.60	2.65	354.5	Flare	Start up 2
1/8/98	9:23	17.75	0.94	1.52	2.23	846.9	Flare	Start up 2
1/8/98	9:24	17.87	0.70	1.53	2.58	529.1	Flare	Start up 2
1/8/98	9:25	19.48	0.51	1.62	2.29	233.7	Flare	Start up 2
1/8/98	9:26	17.81	1.01	1.60	2.12	888.4	Flare	Start up 2

1/8/98	9:27	17.65	0.74	1.59	2.15	531	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:28	18.96	0.50	1.69	2.65	306.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:29	18.58	0.90	1.62	2.25	710.4	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:30	17.74	0.79	1.61	2.28	553.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:31	18.46	0.58	1.64	2.7	384.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:32	19.03	0.75	1.67	2.5	485	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:33	17.63	0.87	1.72	2.48	616.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:34	17.64	0.72	1.78	2.48	484.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:35	19.30	0.46	1.88	2.95	228.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:36	18.17	0.97	1.83	2.37	743.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:37	17.80	0.73	1.82	2.17	476.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:38	17.97	0.67	1.91	2.32	461.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:39	19.33	0.57	1.99	2.55	270.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:40	17.75	0.95	1.96	2.38	740.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:41	17.41	0.76	1.96	2.58	519	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:42	18.48	0.55	1.97	2.66	370.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:43	18.93	0.77	1.98	2.63	514.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:44	17.54	0.87	1.97	2.17	638.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:45	17.64	0.71	1.95	2.17	484.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:46	18.65	0.53	2.00	2.51	344.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:47	18.84	0.80	1.94	2.53	559.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:48	17.62	0.80	1.96	2.13	564.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:49	17.57	0.70	1.97	2.19	491.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:50	18.71	0.52	2.01	2.45	336.4	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:51	18.71	0.83	2.01	2.17	604.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:52	17.68	0.80	1.99	2.03	574.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:53	17.75	0.68	2.01	2.19	464.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:54	18.97	0.48	2.06	2.55	276.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:55	18.64	0.84	2.03	2.18	586.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:56	17.69	0.76	2.07	2.01	505.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:57	17.46	0.72	2.15	1.98	478.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:58	18.44	0.54	2.15	2.43	355.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	9:59	19.00	0.73	2.18	2.12	467.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:00	17.84	0.81	2.19	2.07	572.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:01	17.63	0.69	2.18	2.18	466.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:02	18.21	0.60	2.24	2.36	410.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:03	19.28	0.58	2.26	2.34	305	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:04	17.94	0.85	2.21	2.42	653.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:05	17.57	0.69	2.22	2.37	468.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:06	17.72	0.67	2.26	2.15	462.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:07	19.22	0.45	2.36	2.4	229.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:08	18.20	0.95	2.29	2.32	741.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:09	17.69	0.73	2.30	2.19	497.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:10	17.67	0.68	2.33	2.67	473.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:11	18.41	0.57	2.35	2.47	388.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:12	19.07	0.68	2.38	2.42	430.4	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:13	17.85	0.82	2.38	2.08	613.4	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:14	17.58	0.68	2.44	2.05	484.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:15	17.96	0.64	2.52	2.25	447.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:16	19.35	0.46	2.59	2.86	223.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:17	18.12	0.91	2.51	2.43	726.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:18	17.69	0.70	2.52	2.31	461.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:19	17.39	0.70	2.56	2.02	485.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:20	18.03	0.60	2.53	2.47	427.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:21	19.32	0.55	2.55	2.7	265.4	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:22	17.87	0.94	2.47	2.27	759.2	Flare	Start up 2	Reformer Pilot Burner

1/8/98	10:23	17.56	0.71	2.41	2.42	498.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:24	17.66	0.69	2.35	2.24	485.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:25	18.66	0.52	2.30	2.71	350	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:26	18.71	0.80	2.15	2.38	575.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:27	17.63	0.80	2.03	2.52	571.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:28	17.49	0.70	1.94	2.25	501.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:29	17.75	0.68	1.86	2.16	488.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:30	19.05	0.48	1.85	2.28	284.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:31	18.43	0.89	1.69	2.29	691.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:32	17.67	0.76	1.68	2.28	531.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:33	17.58	0.68	1.60	2.17	508.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:34	17.54	0.70	1.61	2.12	566.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:35	19.22	0.45	1.60	2.65	284.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:36	18.34	0.95	1.47	2.6	855.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:37	17.76	0.75	1.43	2.7	618.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:38	17.48	0.72	1.31	2.45	616.4	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:39	18.06	0.65	1.22	2.54	519.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:40	19.35	0.51	1.22	2.82	256.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:41	17.80	1.00	1.17	2.41	747.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:42	17.39	0.74	1.09	2.49	499	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:43	17.41	0.71	1.06	2.61	478	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:44	17.44	0.70	1.01	3.09	492.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:45	18.43	0.56	1.01	3.24	383.4	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:46	19.16	0.71	0.95	3.31	440.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:47	17.98	0.89	0.82	3.15	668.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:48	17.55	0.74	0.78	2.58	511.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:49	17.55	0.73	0.73	2.46	495.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:50	17.88	0.69	0.70	2.54	479.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:51	19.40	0.50	0.69	3.14	242.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:52	17.89	1.03	0.60	2.81	759.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:53	17.75	0.71	0.52	2.48	460.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:54	17.50	0.71	0.52	2.5	464.3	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:55	17.57	0.70	0.54	2.56	457.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:56	18.22	0.61	0.57	2.95	422.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:57	19.43	0.57	0.56	2.57	323.4	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:58	18.04	0.95	0.57	2.29	859.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	10:59	17.97	0.69	0.54	2.19	565.4	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:00	17.84	0.69	0.57	2.21	598.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:01	18.35	0.63	0.57	2.71	543	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:02	19.23	0.60	0.63	2.36	404.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:03	17.84	0.90	0.61	2.63	701.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:04	17.42	0.72	0.61	2.07	483.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:05	17.39	0.70	0.60	1.86	443.7	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:06	17.45	0.69	0.59	1.91	448.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:07	17.90	0.65	0.70	2.05	425	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:08	19.54	0.48	0.75	2.35	195.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:09	18.11	1.03	0.71	2.05	769.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:10	17.71	0.75	0.74	2.23	458	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:11	17.52	0.71	0.74	1.99	446.9	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:12	17.35	0.72	0.78	1.94	464.6	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:13	17.69	0.69	0.77	1.92	428	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:14	19.05	0.47	0.83	2.34	250.2	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:15	18.64	0.91	0.83	2.35	588.8	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:16	17.70	0.76	0.83	2.15	496.5	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:17	19.42	0.40	0.93	2.35	159.1	Flare	Start up 2	Reformer Pilot Burner
1/8/98	11:18	19.68	0.39	0.98	2.12	137.9	Flare	Start up 2	Reformer Pilot Burner

Date	Time	O2 %	CO2 %	NOx ppm	THC ppm	CO-lo ppm	Location	Condition
1/8/98	11:19	17.47	1.82	0.89	98.31	1661.6	Flare	Start up 2 Begin Reformation
1/8/98	11:20	15.65	2.53	0.96	25.25	2046	Flare	Start up 2 Begin Reformation
1/8/98	11:21	15.73	2.54	1.09	11.62	2046	Flare	Start up 2 Begin Reformation
1/8/98	11:22	15.84	2.39	1.13	6.89	2046.1	Flare	Start up 2 Begin Reformation
1/8/98	11:23	15.78	2.48	1.17	4.91	2046.1	Flare	Start up 2 Begin Reformation
1/8/98	11:24	15.60	2.56	1.22	4.09	2046.2	Flare	Start up 2 Begin Reformation
1/8/98	11:25	16.82	2.11	1.03	3.84	1572.3	Flare	Start up 2 Begin Reformation
1/8/98	11:26	16.68	2.58	0.98	2.66	604.6	Flare	Start up 2 Begin Reformation
1/8/98	11:27	16.24	2.70	0.97	3.38	479	Flare	Start up 2 Begin Reformation
1/8/98	11:28	16.26	2.71	0.97	4.49	416.7	Flare	Start up 2 Begin Reformation
1/8/98	11:29	15.83	2.96	1.05	3.83	267.9	Flare	Start up 2 Begin Reformation
1/8/98	11:30	15.79	2.89	0.95	3.61	453.5	Flare	Start up 2 Begin Reformation
1/8/98	11:31	15.79	2.98	0.97	4.72	486.4	Flare	Start up 2 Begin Reformation
1/8/98	11:32	15.56	3.07	1.70	3.4	90.3	Flare	Start up 2 Begin Reformation
1/8/98	11:33	15.76	2.95	1.74	3.87	41.5	Flare	Start up 2 Begin Reformation
1/8/98	11:34	14.84	3.53	1.67	3.07	52.3	Flare	Start up 2 Begin Reformation
1/8/98	11:35	14.78	3.49	1.48	3.22	61.4	Flare	Start up 2 Begin Reformation
1/8/98	11:36	14.90	3.39	1.95	2.74	37.6	Flare	Start up 2 Begin Reformation
1/8/98	11:37	15.02	3.34	1.84	3.52	36.7	Flare	Start up 2 Begin Reformation
1/8/98	11:38	14.84	3.49	1.74	3.74	43.6	Flare	Start up 2 Begin Reformation
1/8/98	11:39	14.65	3.55	1.80	3.28	44.3	Flare	Start up 2 Begin Reformation
1/8/98	11:40	14.82	3.42	2.10	4.32	37.9	Flare	Start up 2 Begin Reformation
1/8/98	11:41	14.74	3.51	2.08	3.82	37.3	Flare	Start up 2 Begin Reformation
1/8/98	11:42	14.52	3.62	1.91	3.71	42.6	Flare	Start up 2 Begin Reformation
1/8/98	11:43	14.89	3.37	1.96	3.58	39.6	Flare	Start up 2 Begin Reformation
1/8/98	11:44	14.86	3.44	2.20	3.14	34.8	Flare	Start up 2 Begin Reformation
1/8/98	11:45	14.86	3.42	2.19	3.61	34.7	Flare	Start up 2 Begin Reformation
1/8/98	11:46	14.38	3.73	2.27	2.84	41.1	Flare	Start up 2 Begin Reformation
1/8/98	11:47	14.50	3.63	2.25	3.16	39.3	Flare	Start up 2 Begin Reformation
1/8/98	11:48	14.48	3.61	2.49	3.86	35.8	Flare	Start up 2 Begin Reformation
1/8/98	11:49	14.61	3.55	2.44	3.6	35.1	Flare	Start up 2 Begin Reformation
1/8/98	11:50	14.45	3.67	2.34	3.58	39	Flare	Start up 2 Begin Reformation
1/8/98	11:51	14.33	3.72	2.32	3.04	38.1	Flare	Start up 2 Begin Reformation
1/8/98	11:52	14.53	3.56	2.39	3.41	34.8	Flare	Start up 2 Begin Reformation
1/8/98	11:53	14.65	3.57	2.53	4.21	34.1	Flare	Start up 2 Begin Reformation
1/8/98	11:54	14.29	3.75	2.49	3.22	39	Faire	Start up 2 Begin Reformation
1/8/98	11:55	14.44	3.64	2.31	3.15	37.9	Flare	Start up 2 Begin Reformation
1/8/98	11:56	14.62	3.53	2.32	3.48	34.3	Flare	Start up 2 Begin Reformation
1/8/98	11:57	14.67	3.50	2.39	3.03	33.7	Flare	Start up 2 Begin Reformation
1/8/98	11:58	14.53	3.64	2.39	2.64	33.7	Flare	Start up 2 Begin Reformation
1/8/98	11:59	14.30	3.74	2.38	3.15	38.9	Flare	Start up 2 Begin Reformation
1/8/98	12:00	14.67	3.46	2.27	3.14	34.6	Flare	Start up 2 Begin Reformation
1/8/98	12:01	14.97	3.36	2.25	3.14	31.4	Flare	Start up 2 Begin Reformation
1/8/98	12:02	14.45	3.74	2.37	3.2	36.3	Flare	Start up 2 Begin Reformation
1/8/98	12:03	14.33	3.69	2.26	2.62	35.1	Flare	Start up 2 Begin Reformation
1/8/98	12:04	14.54	3.57	2.26	2.51	32.9	Flare	Start up 2 Begin Reformation
1/8/98	12:05	14.67	3.55	2.30	3.27	33.2	Flare	Start up 2 Begin Reformation
1/8/98	12:06	14.53	3.62	2.28	3.3	34.9	Flare	Start up 2 Begin Reformation
1/8/98	12:07	14.40	3.71	2.23	3.02	37.4	Flare	Start up 2 Begin Reformation

Date	Time	CO2 %	NOx ppm	THC ppm	Location	Condition
1/8/98	12:46	4.22	0.44	71.04	1 POX after quench	Full Load
1/8/98	12:47	4.20	0.41	71.53	1 POX after quench	Full Load
1/8/98	12:48	4.24	0.40	67.11	1 POX after quench	Full Load
1/8/98	12:49	4.13	0.42	81.62	1 POX after quench	Full Load
1/8/98	12:50	4.09	0.43	85.35	1 POX after quench	Full Load
1/8/98	12:51	4.11	0.44	80.39	1 POX after quench	Full Load
1/8/98	12:52	4.23	0.44	62.18	1 POX after quench	Full Load
1/8/98	12:53	4.22	0.46	71.63	1 POX after quench	Full Load
1/8/98	12:54	4.13	0.46	71.84	1 POX after quench	Full Load
1/8/98	12:55	4.11	0.45	79.98	1 POX after quench	Full Load
1/8/98	12:56	4.12	0.44	72.52	1 POX after quench	Full Load
1/8/98	12:57	4.20	0.41	71.50	1 POX after quench	Full Load
1/8/98	12:58	4.10	0.40	88.86	1 POX after quench	Full Load
1/8/98	12:59	4.12	0.37	75.88	1 POX after quench	Full Load
1/8/98	13:00	4.18	0.34	73.86	1 POX after quench	Full Load
1/8/98	13:01	4.22	0.31	67.68	1 POX after quench	Full Load
1/8/98	13:02	4.12	0.28	68.00	1 POX after quench	Full Load
1/8/98	13:03	4.04	0.22	78.28	1 POX after quench	Full Load
1/8/98	13:04	4.21	0.19	63.70	1 POX after quench	Full Load
1/8/98	13:05	4.19	0.16	68.16	1 POX after quench	Full Load
1/8/98	13:06	4.10	0.11	81.28	1 POX after quench	Full Load
1/8/98	13:07	4.10	0.06	79.49	1 POX after quench	Full Load
1/8/98	13:08	4.12	0.02	72.12	1 POX after quench	Full Load
1/8/98	13:09	4.14	-0.02	55.53	1 POX after quench	Full Load
1/8/98	13:10	4.20	-0.07	47.51	1 POX after quench	Full Load
1/8/98	13:11	4.21	-0.11	50.49	1 POX after quench	Full Load
1/8/98	13:12	4.04	-0.15	59.67	1 POX after quench	Full Load
1/8/98	13:13	4.07	-0.19	51.93	1 POX after quench	Full Load
1/8/98	13:14	4.29	-0.23	39.03	1 POX after quench	Full Load
1/8/98	13:15	6.10	-0.26	46.81	1 POX after quench	Full Load
Date	Time	CO2 %	NOx ppm	THC ppm	Location	Condition
1/8/98	13:27	8.21	0.37	39.44	2 HTS exit	Full Load
1/8/98	13:28	8.22	0.38	48.02	2 HTS exit	Full Load
1/8/98	13:29	8.22	0.36	46.16	2 HTS exit	Full Load
1/8/98	13:30	8.20	0.35	41.92	2 HTS exit	Full Load
1/8/98	13:31	8.19	0.32	41.69	2 HTS exit	Full Load
1/8/98	13:32	8.20	0.30	39.40	2 HTS exit	Full Load
1/8/98	13:33	8.16	0.27	45.02	2 HTS exit	Full Load
1/8/98	13:34	7.75	0.27	42.51	2 HTS exit	Full Load
1/8/98	13:35	6.42	0.27	38.21	2 HTS exit	Full Load
1/8/98	13:36	6.08	0.25	39.97	2 HTS exit	Full Load
1/8/98	13:37	9.11	0.19	52.64	2 HTS exit	Full Load
1/8/98	13:38	8.82	0.15	44.00	2 HTS exit	Full Load
1/8/98	13:39	8.77	0.13	43.55	2 HTS exit	Full Load
1/8/98	13:40	8.75	0.12	46.30	2 HTS exit	Full Load
1/8/98	13:41	8.74	0.13	43.75	2 HTS exit	Full Load
1/8/98	13:42	8.77	0.14	49.29	2 HTS exit	Full Load
1/8/98	13:43	8.75	0.16	47.80	2 HTS exit	Full Load
1/8/98	13:44	8.75	0.18	47.09	2 HTS exit	Full Load
1/8/98	13:45	8.76	0.20	48.53	2 HTS exit	Full Load
1/8/98	13:46	8.75	0.23	49.45	2 HTS exit	Full Load
1/8/98	13:47	8.74	0.25	45.36	2 HTS exit	Full Load

1/8/98	13:48	8.76	0.28	44.65	2 HTS exit	Full Load
1/8/98	13:49	8.75	0.31	49.56	2 HTS exit	Full Load
1/8/98	13:50	8.80	0.33	47.13	2 HTS exit	Full Load
1/8/98	13:51	8.76	0.35	43.51	2 HTS exit	Full Load
1/8/98	13:52	8.77	0.39	50.90	2 HTS exit	Full Load
1/8/98	13:53	8.76	0.39	44.19	2 HTS exit	Full Load
1/8/98	13:54	8.79	0.40	44.46	2 HTS exit	Full Load
1/8/98	13:55	8.76	0.42	50.53	2 HTS exit	Full Load
1/8/98	13:56	8.77	0.44	48.27	2 HTS exit	Full Load
1/8/98	13:57	8.77	0.43	47.54	2 HTS exit	Full Load
1/8/98	13:58	8.78	0.43	48.98	2 HTS exit	Full Load
1/8/98	13:59	8.81	0.43	44.64	2 HTS exit	Full Load
1/8/98	14:00	8.78	0.44	44.83	2 HTS exit	Full Load
1/8/98	14:01	8.78	0.43	46.81	2 HTS exit	Full Load
1/8/98	14:02	8.83	0.41	51.10	2 HTS exit	Full Load
1/8/98	14:03	8.82	0.39	46.71	2 HTS exit	Full Load
1/8/98	14:04	8.82	0.37	46.98	2 HTS exit	Full Load
1/8/98	14:05	8.86	0.36	44.13	2 HTS exit	Full Load
1/8/98	14:06	8.89	0.35	46.51	2 HTS exit	Full Load
1/8/98	14:07	8.89	0.35	49.82	2 HTS exit	Full Load
Date	Time	CO2 %	NOx ppm	THC ppm	Location	Condition
1/8/98	14:54	9.43	0.81	51.24	3 HTS after Condenser	Full Load
1/8/98	14:55	9.43	0.80	46.79	3 HTS after Condenser	Full Load
1/8/98	14:56	9.44	0.81	54.53	3 HTS after Condenser	Full Load
1/8/98	14:57	9.22	0.86	46.79	3 HTS after Condenser	Full Load
1/8/98	14:58	9.31	0.93	48.42	3 HTS after Condenser	Full Load
1/8/98	14:59	9.30	0.96	51.28	3 HTS after Condenser	Full Load
1/8/98	15:00	9.30	0.98	45.95	3 HTS after Condenser	Full Load
1/8/98	15:01	9.31	1.01	49.60	3 HTS after Condenser	Full Load
1/8/98	15:02	9.33	1.04	59.15	3 HTS after Condenser	Full Load
1/8/98	15:03	9.34	1.08	54.10	3 HTS after Condenser	Full Load
1/8/98	15:04	9.35	1.10	47.76	3 HTS after Condenser	Full Load
1/8/98	15:05	9.32	1.15	45.06	3 HTS after Condenser	Full Load
1/8/98	15:06	9.32	1.20	46.87	3 HTS after Condenser	Full Load
1/8/98	15:07	9.33	1.24	49.98	3 HTS after Condenser	Full Load
1/8/98	15:08	9.34	1.28	59.77	3 HTS after Condenser	Full Load
1/8/98	15:09	9.34	1.35	53.33	3 HTS after Condenser	Full Load
1/8/98	15:10	9.35	1.42	52.46	3 HTS after Condenser	Full Load
1/8/98	15:11	9.36	1.45	50.09	3 HTS after Condenser	Full Load
1/8/98	15:12	9.34	1.52	52.18	3 HTS after Condenser	Full Load
1/8/98	15:13	9.36	1.61	59.21	3 HTS after Condenser	Full Load
1/8/98	15:14	9.31	1.65	65.93	3 HTS after Condenser	Full Load
1/8/98	15:15	9.38	1.72	62.90	3 HTS after Condenser	Full Load
1/8/98	15:16	9.38	1.90	51.80	3 HTS after Condenser	Full Load
1/8/98	15:17	9.36	2.23	50.89	3 HTS after Condenser	Full Load
1/8/98	15:18	9.36	2.06	49.31	3 HTS after Condenser	Full Load
1/8/98	15:19	9.36	2.11	59.04	3 HTS after Condenser	Full Load
1/8/98	15:20	9.37	2.17	64.61	3 HTS after Condenser	Full Load
1/8/98	15:21	9.38	2.21	58.84	3 HTS after Condenser	Full Load
1/8/98	15:22	9.37	2.31	57.86	3 HTS after Condenser	Full Load
1/8/98	15:23	9.38	2.33	54.74	3 HTS after Condenser	Full Load
1/8/98	15:24	9.38	2.41	52.83	3 HTS after Condenser	Full Load
1/8/98	15:25	9.39	2.46	60.48	3 HTS after Condenser	Full Load
1/8/98	15:26	9.39	2.54	56.22	3 HTS after Condenser	Full Load

1/8/98	15:27	9.39	2.63	55.78	3 HTS after Condenser	Full Load
Date	Time	CO2 %	NOx ppm	THC ppm	Location	Condition
1/8/98	18:20	9.85	0.73	32.71	3 HTS after Condenser	100% to 80%
1/8/98	18:21	10.09	0.75	26.41	3 HTS after Condenser	100% to 80%
1/8/98	18:22	10.17	0.78	25.47	3 HTS after Condenser	100% to 80%
1/8/98	18:23	10.19	0.81	22.33	3 HTS after Condenser	100% to 80%
1/8/98	18:24	10.17	0.85	25.71	3 HTS after Condenser	100% to 80%
1/8/98	18:25	10.12	0.89	27.73	3 HTS after Condenser	100% to 80%
1/8/98	18:26	10.13	0.92	30.30	3 HTS after Condenser	100% to 80%
1/8/98	18:27	10.15	0.97	28.10	3 HTS after Condenser	100% to 80%
1/8/98	18:28	10.12	1.00	27.43	3 HTS after Condenser	100% to 80%
1/8/98	18:29	10.05	1.06	27.74	3 HTS after Condenser	100% to 80%
1/8/98	18:30	10.06	1.00	26.34	3 HTS after Condenser	100% to 80%
1/8/98	18:31	10.03	0.97	25.92	3 HTS after Condenser	100% to 80%
1/8/98	18:32	10.11	1.02	28.77	3 HTS after Condenser	100% to 80%
1/8/98	18:33	10.06	1.05	28.52	3 HTS after Condenser	100% to 80%
Date	Time	CO2 %	NOx ppm	THC ppm	Location	Condition
1/8/98	18:34	10.07	1.09	26.97	3 HTS after Condenser	80% to 110%
1/8/98	18:35	10.03	1.11	31.19	3 HTS after Condenser	80% to 110%
1/8/98	18:36	9.77	1.14	35.92	3 HTS after Condenser	80% to 110%
1/8/98	18:37	9.53	1.14	46.62	3 HTS after Condenser	80% to 110%
1/8/98	18:38	9.34	1.14	62.22	3 HTS after Condenser	80% to 110%
1/8/98	18:39	9.34	1.11	61.36	3 HTS after Condenser	80% to 110%
1/8/98	18:40	9.38	1.10	45.40	3 HTS after Condenser	80% to 110%
1/8/98	18:41	9.43	1.05	43.81	3 HTS after Condenser	80% to 110%
1/8/98	18:42	9.47	1.01	42.44	3 HTS after Condenser	80% to 110%
1/8/98	18:43	9.51	0.97	45.27	3 HTS after Condenser	80% to 110%
1/8/98	18:44	9.54	0.93	54.27	3 HTS after Condenser	80% to 110%
1/8/98	18:45	9.59	0.87	53.92	3 HTS after Condenser	80% to 110%
1/8/98	18:46	9.65	0.83	47.76	3 HTS after Condenser	80% to 110%
1/8/98	18:47	9.68	0.79	35.41	3 HTS after Condenser	80% to 110%
1/8/98	18:48	9.72	0.73	37.37	3 HTS after Condenser	80% to 110%

Date	Time	CO2 %	NOx ppm	THC ppm	Location	Condition
1/8/98	16:26	10.47	0.83	66.52	3 PSA waste gas	Full Load
1/8/98	16:27	10.31	0.86	63.25	3 PSA waste gas	Full Load
1/8/98	16:28	10.28	0.90	59.87	3 PSA waste gas	Full Load
1/8/98	16:29	10.25	0.95	61.95	3 PSA waste gas	Full Load
1/8/98	16:30	10.26	0.98	59.80	3 PSA waste gas	Full Load
1/8/98	16:31	10.20	1.05	60.18	3 PSA waste gas	Full Load
1/8/98	16:32	10.29	1.10	63.18	3 PSA waste gas	Full Load
1/8/98	16:33	10.25	1.16	62.03	3 PSA waste gas	Full Load
1/8/98	16:34	10.28	1.22	65.88	3 PSA waste gas	Full Load
1/8/98	16:35	10.26	1.29	67.70	3 PSA waste gas	Full Load
1/8/98	16:36	10.28	1.36	61.66	3 PSA waste gas	Full Load
1/8/98	16:37	10.27	1.42	65.08	3 PSA waste gas	Full Load
1/8/98	16:38	10.25	1.50	62.97	3 PSA waste gas	Full Load
1/8/98	16:39	10.26	1.57	64.26	3 PSA waste gas	Full Load
1/8/98	16:40	10.33	1.64	68.56	3 PSA waste gas	Full Load

ATTACHMENT B. RESULTS OF FORMALDEHYDE ANALYSIS

HBT UOBTM System

Formaldehyde
Method USEPA TO-11

Sampling Location	Operating Condition	Formaldehyde (ug)	Formaldehyde (ug/m ³)	Sample Duration (min)	No. of Samples
5. Flare ^a	Full Load C2	1.1	12.6	22.0	1
5. Flare ^a	Full Load C3	3.1	60.9	10.0	1
3. HTS after Condenser	Full load	0.2	2.1	26.0	1
3. HTS after Condenser	100% to 80%	0.7	15.8	5.0	1
4. PSA Waste Gas	Full load	0.1	0.7	27.0	1

^aCorrected to 15% O₂ for the sampling location "Flare", dry basis

Notes:

Formaldehyde samples are a composite drawn through a cartridge

Sample duration for 100% to 80% load change is only 5 min to capture more of the transient event

ATTACHMENT C. RESULTS OF AMMONIA AND MOISTURE ANALYSIS

HBT UOB™ System

Ammonia BAAQMD Method ST-1B				
Total Organic Carbon in Condensate EPA Method 414.1				
Moisture Content Method EPA Method 4				
Sampling Location	Operating Condition	Abs. H ₂ O Content (kg/m ³)	NH ₃ (ppm)	TOC (ppm)
1. POX after quench	Full Load	0.70	71.8	N.D. ^a
2. HTS exit	Full Load	0.50	99.7	N.D.
3. HTS after condenser	Full Load	0.00	0.008	N.D.
4. PSA waste gas	Full Load	0.00	0.000	N.M. ^b
5. Flare ^c	Full Load C2	0.04	0.023	N.M.
5. Flare ^c	Full Load C3	0.03	0.007	N.D.

^a N.D. = Not Detected. Detection Limit < 50 ppm

^b N.M. = Not Measured

^c Corrected to 15% O₂ for the sampling location, dry basis

Notes:

Ammonia, NH₃, is determined by measuring NH₄⁺ in an acidified impinger solution

TOC measurement identifies the organic compounds in the condensate
shown in moles TOC/ million moles gas stream

ATTACHMENT D. RESULTS OF HYDROCARBON SPECIATION

HBT UOBTM System

Table D-1. Summary of HC Speciation Tests

Page	Sample	Sample Location	Operating Condition	Analysis
D-4	4140	5. Flare	C2: PSA waste gas + H ₂ , Full Load	ASTM D-1945
D-5	4140	5. Flare	C2: PSA waste gas + H ₂ , Full Load	EPA TO-14
D-7	4141	5. Flare	C3: PSA waste gas, Full Load	ASTM D-1945
D-8	4141	5. Flare	C3: PSA waste gas, Full Load	EPA TO-14
D-10	4149	1. POX after quench	Full Load	ASTM D-1945
D-11	4149	1. POX after quench	Full Load	EPA TO-14
D-13	4152	2: HTS exit	Full Load	ASTM D-1945
D-14	4152	2: HTS exit	Full Load	EPA TO-14
D-16	4158	3. HTS after condenser	Full Load	ASTM D-1945
D-17	4158	3. HTS after condenser	Full Load	EPA TO-14
D-19	4167	3. HTS after condenser	Transient 80% to 110% Load	ASTM D-1945
D-20	4167	3. HTS after condenser	Transient 80% to 110% Load	EPA TO-14
D-22	4155	4. PSA waste gas	Full Load	ASTM D-1945
D-23	4155	4. PSA waste gas	Full Load	EPA TO-14

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SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4140			
Sample Location:	5. Flare			
Operating Condition:	Full load, C2: PSA waste gas + H ₂			
Method:	ASTM D-1945			
Component:	Reportable Limit (%)	Amount (%)	Amount (g/kWh)	Amount (%) corrected to 15 % O ₂
Oxygen	1.90E-02	17.00	2.79E+02	1.50E+01
Nitrogen	1.90E-02	80.00	1.96E+02	1.20E+02
Carbon Monoxide	2.00E-03	0.00	9.78E-02	6.00E-03
Methane	2.00E-03	ND	ND	ND
Carbon Dioxide	2.00E-03	3.20	1.23E+02	4.80E+00
Ethane	2.00E-03	ND	ND	ND
Propane	2.00E-03	ND	ND	ND
Isobutane	2.00E-03	ND	ND	ND
Butane	2.00E-03	ND	ND	ND
Neopentane	2.00E-03	ND	ND	ND
Isopentane	2.00E-03	ND	ND	ND
n-Pentane	2.00E-03	ND	ND	ND
C ₆ +	1.90E-02	ND	ND	ND
TOTAL w/o H ₂ :		100.00		
H ₂ (%) by on-line GC	-	0.00		
Specific Gravity		1.00		
ND = not detected				

Reportable limit is the combination of the detection limit and diluted sample volume.
 Since all of the Summa canisters are evacuated to a different extent, the dilution
 volume varies from sample to sample.

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4140			
Sample Location:	5. Flare			
Operating Condition:	Full load, C2: PSA waste gas + H2			
Method:	TO-14			
Compound	Reportable Limit (ppbv)	Amount (ppbv)	Amount (mg/kWh)	Amount (ppm) corrected to 15 % O2
Freon 12	1.00E+00	ND	ND	ND
Freon 114	1.00E+00	ND	ND	ND
Chloromethane	1.00E+00	ND	ND	ND
Vinyl Chloride	1.00E+00	ND	ND	ND
Bromomethane	1.00E+00	ND	ND	ND
Chloroethane	1.00E+00	ND	ND	ND
Freon 11	1.00E+00	ND	ND	ND
1,1 Dichloroethene	1.00E+00	ND	ND	ND
Freon 113	1.00E+00	ND	ND	ND
Methylene Chloride	1.00E+00	1.10E+00	4.85E-02	1.65E-03
1,1 Dichloroethane	1.00E+00	ND	ND	ND
cis-1,2-Dichloroethne	1.00E+00	ND	ND	ND
Chloroform	1.00E+00	ND	ND	ND
1,1,1-Trichloroethane	1.00E+00	ND	ND	ND
Carbon Tetrachloride	1.00E+00	ND	ND	ND
Benzene	1.00E+00	2.10E+00	1.43E-01	3.15E-03
1,2-Dichloroethane	1.00E+00	ND	ND	ND
Trichloroethene	1.00E+00	ND	ND	ND
1,2-Dichloropropane	1.00E+00	ND	ND	ND
cis-1,3-Dichloropropene	1.00E+00	ND	ND	ND
Toluene	1.00E+00	2.80E+00	2.25E-01	4.20E-03
trans-1,3-Dichloropropene	1.00E+00	ND	ND	ND
1,1,2-Trichloroethane	1.00E+00	ND	ND	ND
Tetrachloroethene	1.00E+00	ND	ND	ND
Ethylene Dibromide	1.00E+00	ND	ND	ND
Chlorobenzene	1.00E+00	ND	ND	ND
Ethyl Benzene	1.00E+00	ND	ND	ND
m,p-Xylene	1.00E+00	1.00E+00	9.26E-02	1.50E-03
o-Xylene	1.00E+00	ND	ND	ND
Styrene	1.00E+00	ND	ND	ND
1,1,2,2-Tetrachloromethane	1.00E+00	ND	ND	ND
1,3,5-Tetrachloroethane	1.00E+00	ND	ND	ND

1,2,4-Trimethylbenzene	1.00E+00	ND	ND	ND
1,3-Dichlorobenzene	1.00E+00	ND	ND	ND
1,4-Dichlorobenzene	1.00E+00	ND	ND	ND
Chlorotoluene	1.00E+00	ND	ND	ND
1,2-Dichlorobenzene	1.00E+00	ND	ND	ND
1,2,4-Trichlorobenzene	1.00E+00	ND	ND	ND
Hexachlorobutadiene	1.00E+00	ND	ND	ND
Propylene	4.00E+00	ND	ND	ND
1,3-Butadiene	4.00E+00	ND	ND	ND
Acetone	4.00E+00	4.00E+01	1.12E+00	6.00E-02
Carbon Disulfide	4.00E+00	ND	ND	ND
2-Propanol	4.00E+00	ND	ND	ND
trans-1,2-Dichloroethene	4.00E+00	ND	ND	ND
Vinyl Acetate	4.00E+00	ND	ND	ND
Chloroprene	4.00E+00	ND	ND	ND
2-Butanone (Methyl Ethyl Ketone)	4.00E+00	ND	ND	ND
Hexane	4.00E+00	ND	ND	ND
Tetrahydrofuran	4.00E+00	ND	ND	ND
Cyclohexane	4.00E+00	ND	ND	ND
1,4-Dioxan	4.00E+00	1.70E+01	1.31E+00	2.55E-02
Bromodichloromethane	4.00E+00	ND	ND	ND
4-Methyl-2-pentanone	4.00E+00	ND	ND	ND
2-Hexanone	4.00E+00	ND	ND	ND
Dibromochloromethane	4.00E+00	ND	ND	ND
Bromoform	4.00E+00	ND	ND	ND
4-Ethyltoluene	4.00E+00	ND	ND	ND
Ethanol	4.00E+00	9.70E+00	2.71E-01	1.46E-02
Methyl tert-Butyl Ether	4.00E+00	6.70E+00	4.21E-01	1.01E-02
Heptane	4.00E+00	ND	ND	ND

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4141			
Sample Location:	5. Flare			
Operating Condition:	Full load, C3: PSA waste gas only			
Method:	ASTM D-1945			
Component:	Reportable Limit (%)	Amount (%)	Amount (g/kWh)	Amount (%) corrected to 15 % O ₂
Oxygen	1.90E-02	14.00	1.78E+02	1.50E+01
Nitrogen	1.90E-02	82.00	7.31E+02	7.03E+01
Carbon Monoxide	2.00E-03	0.04	3.12E-01	3.00E-02
Methane	2.00E-03	ND	ND	ND
Carbon Dioxide	2.00E-03	3.50	4.91E+01	3.00E+00
Ethane	2.00E-03	ND	ND	ND
Propane	2.00E-03	ND	ND	ND
Isobutane	2.00E-03	ND	ND	ND
Butane	2.00E-03	ND	ND	ND
Neopentane	2.00E-03	ND	ND	ND
Isopentane	2.00E-03	ND	ND	ND
n-Pentane	2.00E-03	ND	ND	ND
C ₆ +	1.90E-02	ND	ND	ND
TOTAL w/o H₂:		100.00		
H ₂ (%) by on-line GC		0.00		
Specific Gravity	1.00			
ND = not detected				

Reportable limit is the combination of the detection limit and diluted sample volume.
 Since all of the Summa canisters are evacuated to a different extent, the dilution volume varies from sample to sample.

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4141			
Sample Location:	5. Flare			
Operating Condition:	Full load, C3: PSA waste gas only			
Method:	TO-14			
Compound	Reportable Limit (ppbv)	Amount (ppbv)	Amount (mg/kWh)	Amount (ppm) corrected to 15 % O ₂
Freon 12	9.40E-01	ND	ND	ND
Freon 114	9.40E-01	ND	ND	ND
Chloromethane	9.40E-01	ND	ND	ND
Vinyl Chloride	9.40E-01	ND	ND	ND
Bromomethane	9.40E-01	ND	ND	ND
Chloroethane	9.40E-01	ND	ND	ND
Freon 11	9.40E-01	ND	ND	ND
1,1 Dichloroethene	9.40E-01	ND	ND	ND
Freon 113	9.40E-01	ND	ND	ND
Methylene Chloride	9.40E-01	1.20E+00	1.93E-04	1.03E-03
1,1 Dichloroethane	9.40E-01	ND	ND	ND
cis-1,2-Dichloroethene	9.40E-01	ND	ND	ND
Chloroform	9.40E-01	ND	ND	ND
1,1,1-Trichloroethane	9.40E-01	ND	ND	ND
Carbon Tetrachloride	9.40E-01	ND	ND	ND
Benzene	9.40E-01	2.60E+00	6.46E-04	2.23E-03
1,2-Dichloroethane	9.40E-01	ND	ND	ND
Trichloroethene	9.40E-01	ND	ND	ND
1,2-Dichloropropane	9.40E-01	ND	ND	ND
cis-1,3-Dichloropropene	9.40E-01	ND	ND	ND
Toluene	9.40E-01	3.30E+00	9.67E-04	2.83E-03
trans-1,3-Dichloropropene	9.40E-01	ND	ND	ND
1,1,2-Trichloroethane	9.40E-01	ND	ND	ND
Tetrachloroethene	9.40E-01	ND	ND	ND
Ethylene Dibromide	9.40E-01	ND	ND	ND
Chlorobenzene	9.40E-01	ND	ND	ND
Ethyl Benzene	9.40E-01	ND	ND	ND
m,p-Xylene	9.40E-01	1.30E+00	4.39E-04	1.11E-03
o-Xylene	9.40E-01	ND	ND	ND
Styrene	9.40E-01	ND	ND	ND
1,1,2,2-Tetrachloromethane	9.40E-01	ND	ND	ND
1,3,5-Tetrachloroethane	9.40E-01	ND	ND	ND

1,2,4-Trimethylbenzene	9.40E-01	ND	ND	ND
1,3-Dichlorobenzene	9.40E-01	ND	ND	ND
1,4-Dichlorobenzene	9.40E-01	ND	ND	ND
Chlorotoluene	9.40E-01	ND	ND	ND
1,2-Dichlorobenzene	9.40E-01	ND	ND	ND
1,2,4-Trichlorobenzene	9.40E-01	ND	ND	ND
Hexachlorobutadiene	9.40E-01	ND	ND	ND
Propylene	3.70E+00	ND	ND	ND
1,3-Butadiene	3.70E+00	ND	ND	ND
Acetone	3.70E+00	3.00E+01	5.54E-03	2.57E-02
Carbon Disulfide	3.70E+00	ND	ND	ND
2-Propanol	3.70E+00	ND	ND	ND
trans-1,2-Dichloroethene	3.70E+00	ND	ND	ND
Vinyl Acetate	3.70E+00	ND	ND	ND
Chloroprene	3.70E+00	ND	ND	ND
2-Butanone (Methyl Ethyl Ketone)	3.70E+00	ND	ND	ND
Hexane	3.70E+00	ND	ND	ND
Tetrahydrofuran	3.70E+00	ND	ND	ND
Cyclohexane	3.70E+00	ND	ND	ND
1,4-Dioxan	3.70E+00	ND	ND	ND
Bromodichloromethane	3.70E+00	ND	ND	ND
4-Methyl-2-pentanone	3.70E+00	ND	ND	ND
2-Hexanone	3.70E+00	ND	ND	ND
Dibromochloromethane	3.70E+00	ND	ND	ND
Bromoform	3.70E+00	ND	ND	ND
4-Ethyltoluene	3.70E+00	ND	ND	ND
Ethanol	3.70E+00	1.00E+01	1.47E-03	8.57E-03
Methyl tert-Butyl Ether	3.70E+00	ND	ND	ND
Heptane	3.70E+00	ND	ND	ND

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4149		
Sample Location:	1. POX after quench		
Operating Condition:	Full load		
Method:	ASTM D-1945		
Component:	Reportable Limit (%)	Amount (%)	Amount (ppm)
Oxygen	1.80E-02	0.00	0.00E+00
Nitrogen	1.80E-02	56.07	5.61E+05
Carbon Monoxide	2.00E-03	14.55	1.45E+05
Methane	2.00E-03	0.02	2.35E+02
Carbon Dioxide	2.00E-03	3.36	3.36E+04
Ethane	2.00E-03	ND	ND
Propane	2.00E-03	ND	ND
Isobutane	2.00E-03	ND	ND
Butane	2.00E-03	ND	ND
Neopentane	2.00E-03	ND	ND
Isopentane	2.00E-03	ND	ND
n-Pentane	2.00E-03	ND	ND
C ₆ +	1.80E-02	ND	ND
TOTAL w/o H₂:	74.00		
H ₂ (%) by on-line GC	29.73		
Specific Gravity	0.74		
ND = not detected			

Reportable limit is the combination of the detection limit and diluted sample volume.
 Since all of the Summa canisters are evacuated to a different extent, the dilution volume varies from sample to sample.

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4149		
Sample Location:	1. POX after quench		
Operating Condition:	Full load		
Method:	TO-14		
Compound	Reportable Limit (ppbv)	Amount (ppbv)	Amount (ppmv)
Freon 12	1.10E+00	ND	ND
Freon 114	1.10E+00	ND	ND
Chloromethane	1.10E+00	ND	ND
Vinyl Chloride	1.10E+00	ND	ND
Bromomethane	1.10E+00	ND	ND
Chloroethane	1.10E+00	ND	ND
Freon 11	1.10E+00	ND	ND
1,1 Dichloroethene	1.10E+00	ND	ND
Freon 113	1.10E+00	ND	ND
Methylene Chloride	1.10E+00	1.37E+00	1.37E-03
1,1 Dichloroethane	1.10E+00	ND	ND
cis-1,2-Dichloroethene	1.10E+00	ND	ND
Chloroform	1.10E+00	ND	ND
1,1,1-Trichloroethane	1.10E+00	ND	ND
Carbon Tetrachloride	1.10E+00	ND	ND
Benzene	1.10E+00	2.52E+00	2.52E-03
1,2-Dichloroethane	1.10E+00	ND	ND
Trichloroethene	1.10E+00	ND	ND
1,2-Dichloropropane	1.10E+00	ND	ND
cis-1,3-Dichloropropene	1.10E+00	ND	ND
Toluene	1.10E+00	ND	ND
trans-1,3-Dichloropropene	1.10E+00	ND	ND
1,1,2-Trichloroethane	1.10E+00	ND	ND
Tetrachloroethene	1.10E+00	ND	ND
Ethylene Dibromide	1.10E+00	ND	ND
Chlorobenzene	1.10E+00	ND	ND
Ethyl Benzene	1.10E+00	ND	ND
m,p-Xylene	1.10E+00	ND	ND
o-Xylene	1.10E+00	ND	ND
Styrene	1.10E+00	ND	ND
1,1,2,2-Tetrachloromethane	1.10E+00	ND	ND
1,3,5-Tetrachloroethane	1.10E+00	ND	ND

1,2,4-Trimethylbenzene	1.10E+00	ND	ND
1,3-Dichlorobenzene	1.10E+00	ND	ND
1,4-Dichlorobenzene	1.10E+00	ND	ND
Chlorotoluene	1.10E+00	ND	ND
1,2-Dichlorobenzene	1.10E+00	ND	ND
1,2,4-Trichlorobenzene	1.10E+00	ND	ND
Hexachlorobutadiene	1.10E+00	ND	ND
Propylene	4.50E+00	ND	ND
1,3-Butadiene	4.50E+00	ND	ND
Acetone	4.50E+00	9.49E+00	9.49E-03
Carbon Disulfide	4.50E+00	ND	ND
2-Propanol	4.50E+00	ND	ND
trans-1,2-Dichloroethene	4.50E+00	ND	ND
Vinyl Acetate	4.50E+00	ND	ND
Chloroprene	4.50E+00	ND	ND
2-Butanone (Methyl Ethyl Ketone)	4.50E+00	ND	ND
Hexane	4.50E+00	ND	ND
Tetrahydrofuran	4.50E+00	ND	ND
Cyclohexane	4.50E+00	ND	ND
1,4-Dioxan	4.50E+00	ND	ND
Bromodichloromethane	4.50E+00	ND	ND
4-Methyl-2-pentanone	4.50E+00	ND	ND
2-Hexanone	4.50E+00	ND	ND
Dibromochloromethane	4.50E+00	ND	ND
Bromoform	4.50E+00	ND	ND
4-Ethyltoluene	4.50E+00	ND	ND
Ethanol	4.50E+00	6.40E+00	6.40E-03
Methyl tert-Butyl Ether	4.50E+00	ND	ND
Heptane	4.50E+00	ND	ND

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4152		
Sample Location:	2. HTS Exit		
Operating Condition:	Full load		
Method:	ASTM D-1945		
Component:	Rpt. Limit (%)	Amount (%)	Amount (ppm)
Oxygen	1.80E-02	0.00	0.00E+00
Nitrogen	1.80E-02	63.78	6.38E+05
Carbon Monoxide	2.00E-03	8.87	8.87E+04
Methane	2.00E-03	0.02	1.61E+02
Carbon Dioxide	2.00E-03	8.33	8.33E+04
Ethane	2.00E-03	ND	ND
Propane	2.00E-03	ND	ND
Isobutane	2.00E-03	ND	ND
Butane	2.00E-03	ND	ND
Neopentane	2.00E-03	ND	ND
Isopentane	2.00E-03	ND	ND
n-Pentane	2.00E-03	ND	ND
C ₆ +	1.80E-02	ND	ND
TOTAL w/o H₂:		81.00	
H ₂ (%) by on-line GC		25.54	
Specific Gravity	0.82		
ND = not detected			

Reportable limit is the combination of the detection limit and diluted sample volume.
 Since all of the Summa canisters are evacuated to a different extent, the dilution
 volume varies from sample to sample.

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4152		
Sample Location:	2. HTS Exit		
Operating Condition:	Full load		
Method:	TO-14		
Compound	Reportable Limit (ppbv)	Amount (ppbv)	Amount (ppmv)
Freon 12	2.30E+00	ND	ND
Freon 114	2.30E+00	ND	ND
Chloromethane	2.30E+00	ND	ND
Vinyl Chloride	2.30E+00	ND	ND
Bromomethane	2.30E+00	ND	ND
Chloroethane	2.30E+00	ND	ND
Freon 11	2.30E+00	ND	ND
1,1 Dichloroethene	2.30E+00	ND	ND
Freon 113	2.30E+00	ND	ND
Methylene Chloride	2.30E+00	ND	ND
1,1 Dichloroethane	2.30E+00	ND	ND
cis-1,2-Dichloroethene	2.30E+00	ND	ND
Chloroform	2.30E+00	ND	ND
1,1,1-Trichloroethane	2.30E+00	ND	ND
Carbon Tetrachloride	2.30E+00	ND	ND
Benzene	2.30E+00	1.49E+01	1.49E-02
1,2-Dichloroethane	2.30E+00	ND	ND
Trichloroethene	2.30E+00	ND	ND
1,2-Dichloropropane	2.30E+00	ND	ND
cis-1,3-Dichloropropene	2.30E+00	ND	ND
Toluene	2.30E+00	3.63E+01	3.63E-02
trans-1,3-Dichloropropene	2.30E+00	ND	ND
1,1,2-Trichloroethane	2.30E+00	ND	ND
Tetrachloroethene	2.30E+00	ND	ND
Ethylene Dibromide	2.30E+00	ND	ND
Chlorobenzene	2.30E+00	ND	ND
Ethyl Benzene	2.30E+00	6.34E+00	6.34E-03
m,p-Xylene	2.30E+00	1.05E+01	1.05E-02
o-Xylene	2.30E+00	ND	ND
Styrene	2.30E+00	ND	ND
1,1,2,2-Tetrachloromethane	2.30E+00	ND	ND
1,3,5-Tetrachloroethane	2.30E+00	ND	ND

1,2,4-Trimethylbenzene	2.30E+00	ND	ND
1,3-Dichlorobenzene	2.30E+00	ND	ND
1,4-Dichlorobenzene	2.30E+00	ND	ND
Chlorotoluene	2.30E+00	ND	ND
1,2-Dichlorobenzene	2.30E+00	ND	ND
1,2,4-Trichlorobenzene	2.30E+00	ND	ND
Hexachlorobutadiene	2.30E+00	ND	ND
Propylene	9.30E+00	ND	ND
1,3-Butadiene	9.30E+00	ND	ND
Acetone	9.30E+00	2.18E+02	2.18E-01
Carbon Disulfide	9.30E+00	ND	ND
2-Propanol	9.30E+00	ND	ND
trans-1,2-Dichloroethene	9.30E+00	ND	ND
Vinyl Acetate	9.30E+00	ND	ND
Chloroprene	9.30E+00	ND	ND
2-Butanone (Methyl Ethyl Ketone)	9.30E+00	ND	ND
Hexane	9.30E+00	ND	ND
Tetrahydrofuran	9.30E+00	ND	ND
Cyclohexane	9.30E+00	ND	ND
1,4-Dioxan	9.30E+00	ND	ND
Bromodichloromethane	9.30E+00	ND	ND
4-Methyl-2-pentanone	9.30E+00	ND	ND
2-Hexanone	9.30E+00	ND	ND
Dibromochloromethane	9.30E+00	ND	ND
Bromoform	9.30E+00	ND	ND
4-Ethyltoluene	9.30E+00	ND	ND
Ethanol	9.30E+00	3.44E+01	3.44E-02
Methyl tert-Butyl Ether	9.30E+00	ND	ND
Heptane	9.30E+00	ND	ND

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4158		
Sample Location:	3. HTS after condenser		
Operating Condition:	Full load		
Method:	ASTM D-1945		
Component:	Reportable Limit (%)	Amount (%)	Amount (ppm)
Oxygen	1.60E-02	0.00	0.00E+00
Nitrogen	1.60E-02	57.94	5.79E+05
Carbon Monoxide	2.00E-03	7.65	7.65E+04
Methane	2.00E-03	0.02	1.81E+02
Carbon Dioxide	2.00E-03	8.39	8.39E+04
Ethane	2.00E-03	ND	ND
Propane	2.00E-03	ND	ND
Isobutane	2.00E-03	ND	ND
Butane	2.00E-03	ND	ND
Neopentane	2.00E-03	ND	ND
Isopentane	2.00E-03	ND	ND
n-Pentane	2.00E-03	ND	ND
C ₆ +	1.60E-02	ND	ND
TOTAL w/o H₂:		74.00	
H ₂ (%) by on-line GC		27.62	
Specific Gravity	0.76		
ND = not detected			

Reportable limit is the combination of the detection limit and diluted sample volume.
 Since all of the Summa canisters are evacuated to a different extent, the dilution
 volume varies from sample to sample.

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4158		
Sample Location:	3. HTS after condenser		
Operating Condition:	Full load		
Method:	TO-14		
Compound	Reportable Limit (ppbv)	Amount (ppbv)	Amount (ppmv)
Freon 12	2.30E+00	ND	ND
Freon 114	2.30E+00	ND	ND
Chloromethane	2.30E+00	ND	ND
Vinyl Chloride	2.30E+00	ND	ND
Bromomethane	2.30E+00	ND	ND
Chloroethane	2.30E+00	ND	ND
Freon 11	2.30E+00	ND	ND
1,1 Dichloroethene	2.30E+00	ND	ND
Freon 113	2.30E+00	ND	ND
Methylene Chloride	2.30E+00	ND	ND
1,1 Dichloroethane	2.30E+00	ND	ND
cis-1,2-Dichloroethene	2.30E+00	ND	ND
Chloroform	2.30E+00	ND	ND
1,1,1-Trichloroethane	2.30E+00	ND	ND
Carbon Tetrachloride	2.30E+00	ND	ND
Benzene	2.30E+00	9.26E+00	9.26E-03
1,2-Dichloroethane	2.30E+00	ND	ND
Trichloroethene	2.30E+00	ND	ND
1,2-Dichloropropane	2.30E+00	ND	ND
cis-1,3-			
Dichloropropene	2.30E+00	ND	ND
Toluene	2.30E+00	2.26E+01	2.26E-02
trans-1,3-			
Dichloropropene	2.30E+00	ND	ND
1,1,2-Trichloroethane	2.30E+00	ND	ND
Tetrachloroethene	2.30E+00	ND	ND
Ethylene Dibromide	2.30E+00	ND	ND
Chlorobenzene	2.30E+00	ND	ND
Ethyl Benzene	2.30E+00	3.95E+00	3.95E-03
m,p-Xylene	2.30E+00	6.55E+00	6.55E-03
o-Xylene	2.30E+00	ND	ND
Styrene	2.30E+00	ND	ND
1,1,2,2-			
Tetrachloromethane	2.30E+00	ND	ND
1,3,5-			
Tetrachloroethane	2.30E+00	ND	ND

1,2,4-Trimethylbenzene	2.30E+00	ND	ND
1,3-Dichlorobenzene	2.30E+00	ND	ND
1,4-Dichlorobenzene	2.30E+00	ND	ND
Chlorotoluene	2.30E+00	ND	ND
1,2-Dichlorobenzene	2.30E+00	ND	ND
1,2,4-Trichlorobenzene	2.30E+00	ND	ND
Hexachlorobutadiene	2.30E+00	ND	ND
Propylene	9.30E+00	ND	ND
1,3-Butadiene	9.30E+00	ND	ND
Acetone	9.30E+00	1.36E+02	1.36E-01
Carbon Disulfide	9.30E+00	ND	ND
2-Propanol	9.30E+00	ND	ND
trans-1,2-Dichloroethene	9.30E+00	ND	ND
Vinyl Acetate	9.30E+00	ND	ND
Chloroprene	9.30E+00	ND	ND
2-Butanone (Methyl Ethyl Ketone)	9.30E+00	ND	ND
Hexane	9.30E+00	ND	ND
Tetrahydrofuran	9.30E+00	ND	ND
Cyclohexane	9.30E+00	ND	ND
1,4-Dioxan	9.30E+00	ND	ND
Bromodichloromethane	9.30E+00	ND	ND
4-Methyl-2-pentanone	9.30E+00	ND	ND
2-Hexanone	9.30E+00	ND	ND
Dibromochloromethane	9.30E+00	ND	ND
Bromoform	9.30E+00	ND	ND
4-Ethyltoluene	9.30E+00	ND	ND
Ethanol	9.30E+00	2.15E+01	2.15E-02
Methyl tert-Butyl Ether	9.30E+00	ND	ND
Heptane	9.30E+00	ND	ND

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4167		
Sample Location:	3. HTS after condenser		
Operating Condition:	Transient 100% to 80% Load		
Method:	ASTM D-1945		
Component:	Reportable Limit (%)	Amount (%)	Amount (ppm)
Oxygen	1.70E-02	0.00	0.00E+00
Nitrogen	1.70E-02	36.70	3.67E+05
Carbon Monoxide	2.00E-03	4.18	4.18E+04
Methane	2.00E-03	0.01	5.05E+01
Carbon Dioxide	2.00E-03	5.77	5.77E+04
Ethane	2.00E-03	ND	ND
Propane	2.00E-03	ND	ND
Isobutane	2.00E-03	ND	ND
Butane	2.00E-03	ND	ND
Neopentane	2.00E-03	ND	ND
Isopentane	2.00E-03	ND	ND
n-Pentane	2.00E-03	ND	ND
C ₆ +	1.70E-02	ND	ND
TOTAL w/o H₂:		46.65	
H ₂ (%) by on-line GC ^a		22.35	
Specific Gravity		0.70	
ND = not detected			

Reportable limit is the combination of the detection limit and diluted sample volume. Since all of the Summa canisters are evacuated to a different extent, the dilution volume varies from sample to sample.

^aTotal of measured gases and H₂ is 69 which is well below the expected value of 100.

The discrepancy is likely a combination of errors in the GC reading and the dilution factor that was applied to the sample. Compositions for Sample 4167 are likely understated by 30 percent.

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1/7-8/98

Sample Name:	4167		
Sample Location:	3. HTS after condenser		
Operating Condition:	Transient 100% to 80% Load		
Method:	TO-14		
Compound	Reportable Limit (ppbv)	Amount (ppbv)	Amount (ppmv)
Freon 12	1.90E+00	ND	ND
Freon 114	1.90E+00	ND	ND
Chloromethane	1.90E+00	ND	ND
Vinyl Chloride	1.90E+00	ND	ND
Bromomethane	1.90E+00	ND	ND
Chloroethane	1.90E+00	ND	ND
Freon 11	1.90E+00	ND	ND
1,1 Dichloroethene	1.90E+00	ND	ND
Freon 113	1.90E+00	ND	ND
Methylene Chloride	1.90E+00	ND	ND
1,1 Dichloroethane	1.90E+00	ND	ND
cis-1,2-Dichloroethene	1.90E+00	ND	ND
Chloroform	1.90E+00	ND	ND
1,1,1-Trichloroethane	1.90E+00	ND	ND
Carbon Tetrachloride	1.90E+00	ND	ND
Benzene	1.90E+00	9.94E+00	9.94E-03
1,2-Dichloroethane	1.90E+00	ND	ND
Trichloroethene	1.90E+00	ND	ND
1,2-Dichloropropane	1.90E+00	ND	ND
cis-1,3-Dichloropropene	1.90E+00	ND	ND
Toluene	1.90E+00	2.45E+01	2.45E-02
trans-1,3-Dichloropropene	1.90E+00	ND	ND
1,1,2-Trichloroethane	1.90E+00	ND	ND
Tetrachloroethene	1.90E+00	ND	ND
Ethylene Dibromide	1.90E+00	ND	ND
Chlorobenzene	1.90E+00	ND	ND
Ethyl Benzene	1.90E+00	3.75E+00	3.75E-03
m,p-Xylene	1.90E+00	6.19E+00	6.19E-03
o-Xylene	1.90E+00	ND	ND
Styrene	1.90E+00	ND	ND
1,1,2,2-Tetrachloromethane	1.90E+00	ND	ND
1,3,5-Tetrachloroethane	1.90E+00	ND	ND

1,2,4-Trimethylbenzene	1.90E+00	ND	ND
1,3-Dichlorobenzene	1.90E+00	ND	ND
1,4-Dichlorobenzene	1.90E+00	ND	ND
Chlorotoluene	1.90E+00	ND	ND
1,2-Dichlorobenzene	1.90E+00	ND	ND
1,2,4-Trichlorobenzene	1.90E+00	ND	ND
Hexachlorobutadiene	1.90E+00	ND	ND
Propylene	7.60E+00	ND	ND
1,3-Butadiene	7.60E+00	ND	ND
Acetone	7.60E+00	5.66E+01	5.66E-02
Carbon Disulfide	7.60E+00	ND	ND
2-Propanol	7.60E+00	ND	ND
trans-1,2-Dichloroethene	7.60E+00	ND	ND
Vinyl Acetate	7.60E+00	ND	ND
Chloroprene	7.60E+00	ND	ND
2-Butanone (Methyl Ethyl Ketone)	7.60E+00	6.88E+00	6.88E-03
Hexane	7.60E+00	ND	ND
Tetrahydrofuran	7.60E+00	ND	ND
Cyclohexane	7.60E+00	ND	ND
1,4-Dioxan	7.60E+00	ND	ND
Bromodichloromethane	7.60E+00	ND	ND
4-Methyl-2-pentanone	7.60E+00	ND	ND
2-Hexanone	7.60E+00	ND	ND
Dibromochloromethane	7.60E+00	ND	ND
Bromoform	7.60E+00	ND	ND
4-Ethyltoluene	7.60E+00	ND	ND
Ethanol	7.60E+00	9.94E+00	9.94E-03
Methyl tert-Butyl Ether	7.60E+00	ND	ND
Heptane	7.60E+00	ND	ND

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1

Sample Name:	4155		
Sample Location:	4. PSA waste gas		
Operating Condition:	Full load		
Method:	ASTM D-1945		
Component:	Reportable Limit (%)	Amount (%)	Amount (ppm)
Oxygen	1.80E-02	0.00	0.00E+00
Nitrogen	1.80E-02	66.55	6.66E+05
Carbon Monoxide	2.00E-03	9.81	9.81E+04
Methane	2.00E-03	0.02	2.39E+02
Carbon Dioxide	2.00E-03	10.61	1.06E+05
Ethane	2.00E-03	ND	ND
Propane	2.00E-03	ND	ND
Isobutane	2.00E-03	ND	ND
Butane	2.00E-03	ND	ND
Neopentane	2.00E-03	ND	ND
Isopentane	2.00E-03	ND	ND
n-Pentane	2.00E-03	ND	ND
C ₆ +	1.80E-02	ND	ND
TOTAL w/o H₂:		87.00	
H ₂ (%) by on-line GC		2.00	
Specific Gravity	0.89		
ND = not detected			

Reportable limit is the combination of the detection limit and diluted sample volume. Since all of the Summa canisters are evacuated to a different extent, the sample volume varies from sample to sample.

SUMMA Cannister analysis, HBT UOB(TM) Burner system from 1

Sample Name:	4155		
Sample Location:	4. PSA waste gas		
Operating Condition:	Full load		
Method:	TO-14		
Compound	Reportable Limit (ppbv)	Amount (ppbv)	Amount (ppmv)
Freon 12	2.00E+00	ND	ND
Freon 114	2.00E+00	ND	ND
Chloromethane	2.00E+00	ND	ND
Vinyl Chloride	2.00E+00	ND	ND
Bromomethane	2.00E+00	ND	ND
Chloroethane	2.00E+00	ND	ND
Freon 11	2.00E+00	ND	ND
1,1 Dichloroethene	2.00E+00	ND	ND
Freon 113	2.00E+00	ND	ND
Methylene Chloride	2.00E+00	ND	ND
1,1 Dichloroethane	2.00E+00	ND	ND
cis-1,2-Dichloroethene	2.00E+00	ND	ND
Chloroform	2.00E+00	ND	ND
1,1,1-Trichloroethane	2.00E+00	ND	ND
Carbon Tetrachloride	2.00E+00	ND	ND
Benzene	2.00E+00	1.86E+01	1.86E-02
1,2-Dichloroethane	2.00E+00	ND	ND
Trichloroethene	2.00E+00	ND	ND
1,2-Dichloropropane	2.00E+00	ND	ND
cis-1,3-Dichloropropene	2.00E+00	ND	ND
Toluene	2.00E+00	3.98E+01	3.98E-02
trans-1,3-Dichloropropene	2.00E+00	ND	ND
1,1,2-Trichloroethane	2.00E+00	ND	ND
Tetrachloroethene	2.00E+00	ND	ND
Ethylene Dibromide	2.00E+00	ND	ND
Chlorobenzene	2.00E+00	ND	ND
Ethyl Benzene	2.00E+00	5.17E+00	5.17E-03
m,p-Xylene	2.00E+00	7.69E+00	7.69E-03
o-Xylene	2.00E+00	ND	ND
Styrene	2.00E+00	ND	ND
1,1,2,2-Tetrachloromethane	2.00E+00	ND	ND
1,3,5-Tetrachloroethane	2.00E+00	ND	ND

1,2,4-Trimethylbenzene	2.00E+00	ND	ND
1,3-Dichlorobenzene	2.00E+00	ND	ND
1,4-Dichlorobenzene	2.00E+00	ND	ND
Chlorotoluene	2.00E+00	ND	ND
1,2-Dichlorobenzene	2.00E+00	ND	ND
1,2,4-Trichlorobenzene	2.00E+00	ND	ND
Hexachlorobutadiene	2.00E+00	ND	ND
Propylene	8.10E+00	ND	ND
1,3-Butadiene	8.10E+00	ND	ND
Acetone	8.10E+00	1.09E+02	1.09E-01
Carbon Disulfide	8.10E+00	ND	ND
2-Propanol	8.10E+00	ND	ND
trans-1,2-Dichloroethene	8.10E+00	ND	ND
Vinyl Acetate	8.10E+00	ND	ND
Chloroprene	8.10E+00	ND	ND
2-Butanone (Methyl Ethyl Ketone)	8.10E+00	ND	ND
Hexane	8.10E+00	ND	ND
Tetrahydrofuran	8.10E+00	ND	ND
Cyclohexane	8.10E+00	ND	ND
1,4-Dioxan	8.10E+00	3.58E+01	3.58E-02
Bromodichloromethane	8.10E+00	ND	ND
4-Methyl-2-pentanone	8.10E+00	ND	ND
2-Hexanone	8.10E+00	ND	ND
Dibromochloromethane	8.10E+00	ND	ND
Bromoform	8.10E+00	ND	ND
4-Ethyltoluene	8.10E+00	ND	ND
Ethanol	8.10E+00	ND	ND
Methyl tert-Butyl Ether	8.10E+00	ND	ND
Heptane	8.10E+00	ND	ND

